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ABSTRACT

To gain the perspective of nine students currently being prepared to become teachers, this study used semi-structured interviews to examine their beliefs about computer-based educational technology. Areas for study included their views on the role of technology in the K-12 classroom, as well as their beliefs about their own skills in using technology and their perspectives on the most effective means of acquiring skills and implementing technology-infused activities into their classroom practice. Analysis found that participants' beliefs could be grouped into eight categories: background information; social dynamics; computers as used by teachers; computers as used by students; curriculum; learning about using computers; knowing about using computers; and availability of computers at school sites. Representative participants' responses in each category are reported, giving a detailed view of these preservice teachers' beliefs. Appendices include the coding structures and coding response tables. Contains 56 references. (Author/AEF)

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Teacher Education Students' Beliefs About Technology

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Abstract

To gain the perspective of nine students currently being prepared to become teachers, this study used semi-structured interviews to examine their beliefs about computer-based educational technology. Areas for study included their views on the role of technology in the K12 classroom, as well as their beliefs about their own skills in using technology and their perspectives on the most effective means of acquiring skills and implementing technology-infused activities into their classroom practice. Analysis found that participants' beliefs could be grouped among eight categories: Background information, social dynamics, computer as used by teachers, computers as used by students, curriculum, learning about using computers, knowing about using computers, and availability of computers at school sites. Representative participants' responses in each category are reported, giving a detailed view of these preservice teachers' beliefs.

Technology, especially computer-related technology, is a major focus of thought and action in the K-12 educational community (President's committee of advisors on science and technology, 1997). Recent research has established a number of requirements that need to be addressed in order for the promise of technology to be realized (e.g., Krajcik, Soloway, Blumenfeld & Marx, 1998). These requirements range from providing up-to-date multimedia computers to schools, installing high speed and high capacity networking to schools and classrooms, creating focused and powerful teacher professional development, and designing and implementing technology embedded and standards-based curriculum. Moreover, American schools face a new round of infusion of new teachers as tens of thousands of teachers retire. This change promises the opportunity to rapidly bring increased technological competence to the classroom. Teachers entering the field of education have a responsibility to acquire the skills needed to be effective technology-using educators (CEO Forum, 1997).

Unfortunately, most teacher education programs offer little opportunity for pre-service teachers to learn about technology or, more importantly, about teaching with technology (Bork, 1991; Willis & Mehlinger, 1996). Many students graduate from teacher preparation programs with little or no ability to use technology effectively either for their own professional productivity or as part of their teaching repertoire (Office of Technology Assessment, 1995; President's committee of advisors on science and technology, 1997). A number of factors contribute to this situation; a shortage of faculty in teacher education programs qualified to address computer-based technologies in depth, scarcity of resources at universities and in field placements, lack of time devoted to technology instruction in the teacher preparation program, and motivational issues among preservice teachers, to name a few.

To gain the perspective of students currently being prepared to become teachers, this study examined the beliefs about educational technology held by nine preservice English teachers. Areas for study included their views on the role of technology in the K12 classroom, as well as their beliefs about their own skills in using technology and their perspectives on the most effective means of acquiring skills and implementing technology-infused activities into their classroom practice. Participants' beliefs about technology have implications for teacher preparation; possible implications are discussed later in this paper in light of the current state of teacher education in technology.

Beliefs are defined here along the lines of Goodenough (1963) as implicit or explicit propositions which are held to be true and are "accepted as guides for assessing the future, are cited in support of decisions, or are referred to in passing judgment on the behavior of others" (p. 151). Crucial to this argument is the role of beliefs in determining courses of action and in shaping knowledge structures. Beliefs, once acquired, are difficult to alter and play a significant role in subsequent knowledge acquisition (Eagly & Chaiken, 1995; Nisbett & Ross, 1980). Teacher education students act on their beliefs during their teacher preparation, affecting their learning within the context of their classroom and field experiences.

Pre-service teachers' beliefs strongly influence how they experience teacher preparation (Bird, Anderson, Sullivan & Swidler, 1993; Richardson, 1996). What students believe at the beginning of their preparation process colors their perception of their experiences and may influence their ability to learn and grow during their teacher preparation years. Richardson (Richardson, 1996) cites three sources of pre-service teacher beliefs: Personal experience (Clandinin, 1986), experience in school (Lortie, 1975) and experience with formal knowledge (John, 1991).

Beliefs about technology that are based on personal experience may be unrepresentative of the current educational condition (Buchmann & Schwille, 1983; Nisbett & Ross, 1980). Students whose primary experience with computing has come through home use may, for instance, incorrectly assume that most computers in k-12 classrooms are Windows-based computers which are used to play games and connect to the Internet. Complicating the problematic nature of beliefs based on personal experience, research indicates that teacher education students are likely to have little personal experience with computer-based technology in education (Bork, 1991; Willis & Mehlinger, 1996). Absent significant experience, their beliefs may not be well-formed or may be based on widespread myths perpetrated by media and entertainment.

For teacher education students' beliefs regarding computer-based technology, their own experiences in school as K-12 students may not represent the current state of affairs in schools in general or the situation which they will encounter in their student teaching and later in their careers as teachers. This may be an unexpected benefit; unlike almost any other facet of education, pre-service teachers are likely to have experienced relatively few instances of teaching and learning which incorporate computer-based technology. Compare the number of lectures a pre-service teacher may have seen with the number of computer-based learning sessions in which she has participated. If her experience is not unusual, the number of lectures will be several orders of magnitude larger. It may be that beliefs about technology will be less deeply-rooted than beliefs about other areas of education. Still, challenging beliefs based even on relatively limited exposure can be difficult due to pre-service teachers' combination of experience as students and lack of experience in and valuing of reflection on teaching and learning (Bird et al., 1993).

The literature on teacher education students' experience with formal knowledge about computer-based technology indicates that such experience is likely to be limited (Office of Technology Assessment, 1995). The rapid pace of change in our conception of the purposes of technology use in k-12 education has made the knowledge landscape extremely fluid. Beliefs about technology which arise from formal knowledge are therefore prone to becoming quickly outdated. As regards educational technology, teacher preparation has changed significantly in recent years. The literature reflects these changes, while noting that the current system is still undergoing needed transformations.

In the 1980's, free-standing courses on educational technology became the norm in many teacher education programs (Byrum & Cashman, 1993). These courses addressed a perceived need for basic competency in the use of computers and related technology, but they fell short in that they failed to model technology as used in educational settings (Willis & Mehlinger, 1996). Rather than illustrating classroom uses of technology, free-standing courses taught basic computer literacy skills in isolation from K-12 teaching and learning objectives and practices. To address this shortcoming, learning about technology was incorporated into teaching methods courses (Blanchard, 1994; Willis & Mehlinger, 1996). While incorporation into methods studies more closely models how technology might be used in the classroom, the skills of methods instructors in using technology vary widely (Willis & Mehlinger, 1996), leading some technology integration instruction to be more valuable than others. Whether free-standing or incorporated into other classrooms, though, teacher preparation to use technology remains inadequate (Office of Technology Assessment, 1995; Willis & Mehlinger, 1996).

What are the impediments to learning about technology use? The most widely cited is a lack of time during the teacher education process (Knupfer, 1988). Lack of access to computers is also frequently cited as an inhibitor to learning about technology (Byrum & Cashman, 1993).

What do teacher education students themselves believe about their own skills and about the role of technology in their teaching? Byrum and Cashman (1993) report that most participants in their study felt prepared to integrate computers into their classroom teaching practices, despite having had no coursework which exposed them to such teaching. When they do envision specific uses of

computers in their classrooms, teacher education students tend to picture conservative uses of computers such as running drill and practice software and as an aid to teacher presentations, which is often a transmission-oriented teaching strategy (Byrum & Cashman, 1993; Means, 1994). Perhaps more troubling, some teacher education students are unable to envision any classroom use of technology whatsoever (Hunt & Bohlin, 1992).

The research literature cited above is based on survey data. While these data are useful in determining correlations between well-defined variables, they may fail to capture the complexity of participants' views (Seidman, 1991). In the current study, by capitalizing on the richness of interview data, I hope to paint a fuller and more personalized picture of teacher education students' beliefs about technology than has been portrayed by previous studies. The results of the current study attempt to portray teacher education students' beliefs in their own voices, an objective which is difficult if not impossible to attain through survey research.

An additional motivation for studying the current beliefs of teacher education students regarding technology is that the role of computers in education, as elsewhere in society, is growing and changing rapidly. One of the most important changes in the use of the computer has been the rise of the computer as a communication tool. Where very recently the computer was used and viewed as a stand-alone information processing and document production tool, computers are now used and viewed as portals to the Internet through electronic mail and the World Wide Web. The nature of the beliefs of the participants in this study, reflective of these changes in the role of computers in society and education, may be substantially different from the beliefs of teacher education students even as recently as two years ago.

The question this study addressed is the following: "What are the beliefs of preservice English teachers regarding the role of computer-based technology in K-12 education?" By addressing this question, I hope to add to the information available to the educational research community and to shed light on how preparation of teacher education students to use technology in their teaching might best be accomplished.

Method

Participants

The preparation of English teachers has not been a focus of many research studies into technology use and teaching (Blanchard, 1994). This is especially unfortunate in that according to the Michigan Department of Education and Quality Education Data of Denver (1997), language arts and English classes use computer-based technology more than other K-12 subject area classes. By concentrating in this study on English teachers, I hope to address in some small measure the imbalance of research into technology and English.

At the beginning of the fall term of 1997, eleven English teacher education students were enrolled in a twenty-five member cohort of a year-long, field-based teacher preparation program at a large Midwestern research university. Ten of the eleven English teacher education students were approached to take part in the study; all agreed to participate. One potential participant was inadvertently omitted from the potential participant pool. One identified participant withdrew from the teacher preparation program approximately one month after being placed in a high school internship, so she was dropped from the participant pool. A second participant, Byron Karabotsos[1], withdrew from the program in December of the fall semester. As his initial interview had been transcribed, his interview data remained in the data set. Analysis of the transcript from

[1] Throughout this paper, all participant names, cooperating teacher names and school sites are pseudonyms.

his first round interview showed that his responses did not vary substantially from the views of other participants.

Table 1 lists the participants in alphabetical order by last name, along with some background information about each participant. Teaching experience prior to entry into the master's program is included. Also included is information on students' place of origin. For study purposes, I believe this was a significant factor in their K-12 education, which in turn may have shaped their beliefs about technology use in the classroom.

Table 1: Participants

Name	Teaching Experience	Background Information
Barnard, Gary	None	Illinois native.
Greenwalt, Barbara	None	Michigan native.
Hendry, Amira	Teacher of English as a second language	Michigan native, but much time overseas
Karabotsos, Byron	Substitute teaching	Michigan native. Removed himself from the program.
Mallery, Cheryl	College level English lecturer	Canadian native.
Needham, Dawn	Peace Corps volunteer	Michigan native, but much time overseas.
Sims, Aaron	Tutor at private test preparation service	New Jersey native.
Soles, Beth	Elementary school teacher at a private school	Michigan native, but had traveled extensively.
Stout, Quentin	None	New Jersey native. Attended high school in Michigan.

Opportunities for computer-based skills acquisition

The teacher preparation program in which these individual participate is intensive; teacher education students attended classes and participated in a field based experience called an externship in July and August. Externships were opportunities for teacher education students to have contact with K-12 students in educational or recreational settings. Most of these opportunities involved one-on-one or small group tutoring with school age children.

During the fall term, teacher education students began their placements in middle or high schools two days per week. The remaining three days of the week were spent at the university campus, completing courses required for the Master's degree portion of their program.

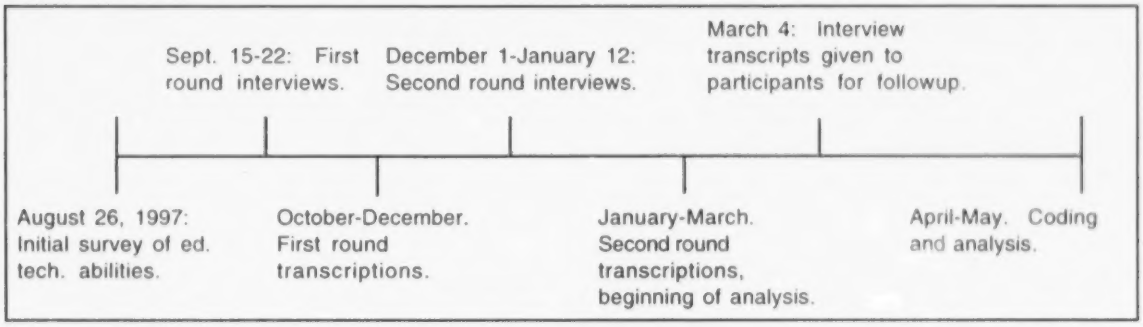
Participants had two opportunities to acquire technology skills: First, each of the schools in which the teacher education students are placed had some computer facilities for use for students and staff. Several of the teacher education students indicated their intention to keep track of grades electronically and nearly all of the teacher education students were active users of electronic mail. These two uses of technology brought most teacher education students into contact with the computers available at their school sites, in cases where such computers were available.

Second, teacher education students had an opportunity to participate in an optional three hour instructional technology practicum held at the school of education at their university. Responding to an informal poll conducted in the summer of 1997, a majority of the teacher education students indicated that they would take part in these sessions. However, few of the participants in this study chose to attend the optional sessions. Most cited schedule conflicts with other classes.

Materials and Procedure

Below is the time line for this study, indicating major milestones:

Figure 1: Time line


Sept. 15-22: First round interviews.
December 1-January 12: Second round interviews.
March 4: Interview transcripts given to participants for followup.
August 26, 1997: Initial survey of ed. tech. abilities.
October-December. First round transcriptions.
January-March. Second round transcriptions, beginning of analysis.
April-May. Coding and analysis.

As a means of gauging students' incoming technology capabilities, all of the teacher education students, including the participants in this study, completed a brief survey of their technological skills during August. Survey results indicated that all of the participants had at least a basic knowledge of computer use for their own purposes.

For the study itself, two semi-structured interviews were held with each participant. The interviews were scheduled at the beginning and end of the participants' first semester in their field placement, hoping to capture changes in participants' beliefs over the course of the semester.

First interview. The first interview (see Table 2 below) was designed to probe participants' background experience and initial beliefs about the use of educational technology, both in their own practice and as they envisioned technology most profitably used in educational settings in general. Some elements of this protocol were influenced by Meyers' (1997) dissertation. To serve as a pilot, an English teacher education student who was not a participant in this study was interviewed using the first interview protocol.

While the same protocol was followed for each interview in the first round, conversations varied somewhat due to the individual interests and experiences of the participants. In general, participants seemed open to the interview questions and comfortable with the format. At the time the interview was conducted, I did not know the participants well; consequently, considerable time in the interviews was spent on background information. While this information enriched the descriptive context in which I placed the participants' responses, much of it did not deal directly with their beliefs about technology and its place in the classroom.

Table 2: First interview protocol

Questions	Areas of interest
Background	
Tell me about yourself; what's your background?	How does participant view self? As student, worker, academic, soon-to-be teacher?
You're planning on being a language arts teacher. How did you come to that field?	
How did you use computers as a student in your k12 classes?	Classroom and lab use, CD-ROM research, presentations, communication. Consumer vs. producer orientation
As a college student, undergraduate and/or graduate, how have you used computers in the classes you took?	In class use: Science labs, writing labs. Transmission of content of production of artifacts?
How have you used computers in your life for your own personal productivity?	Writing papers, presentation, communication.
How have you used computers as an employee in jobs that you have held?	
Beliefs	
In your professional life as a teacher, how do you think you'll use computers for your own productivity and instructional management?	Professional uses, such as test preparation, grade recording, etc. (student teaching year and beyond). Looking for vision of self as teacher.
How do you see using computers as part of your classroom environment and curriculum?	Integration of technology into pedagogy, tool v task view of technology, teaching content v method, etc.
Are there things which computer-based technologies are used for in schools which are negative for teachers (in general and for you specifically)?	Drawbacks to the use of technology, possible downsides for teachers.
Do you think that technology is best used in certain subject areas?	Influence of subject area background.
How will your students use computers for their own personal productivity?	Look for non-classroom uses of computers, such as word processing, research, etc. (student teaching year and beyond)
In general (and economic issues aside), what are some of the best uses for computer based technologies in k12 schools?	Vision of best-case and best-use scenarios.
Are there things which computer-based technologies are used for in schools which are negative for students?	What are the downsides?
Are computer-based activities better suited for some kids than for others?	Ages? Kinds of kids? SES? Bias issues?
As you go through this year, what kinds of technology skills are you hoping to acquire? How will you acquire them?	Prediction about what will be gained in educational technology.

Second interview. Conducted in December of 1997 and January of 1998, the second interview (See Table 3) focused on the experiences which students had over the three month course of the study. The second interview also referenced first round responses of the individual participants, so that participants could comment on their earlier responses from the vantage point of their increased experience. The protocol for this interview, while similar to that of the first, was in part shaped by the results of the first round of interviews. Specifically, questions in the second interview were more focused on computer-based technology and its place in the classroom, with less background and context information.

The second interview protocol was divided into three sections. In the first section, participants were asked about their observations and use of technology during the three months which had passed since the initial interview. The second section sought information about technological skills and knowledge which the participants might have acquired or enriched during the same time period. In the final section of the second interview, participants were asked about their current beliefs about the role of technology. They were also prompted with their initial responses from the first interview, and asked to comment on how their beliefs might or might not be different after three months in the classroom than they had been in September.

Table 3: Second interview protocol

Questions	Areas of interest
Observations from first semester	
In your work at the schools this semester, what kinds of things have you seen your cooperating teacher or other teachers do with technology?	Did intern observe teachers using technology? What was her opinion about the use of technology?
Also at your school site, have you seen students using technology?	When technology was used, were kids participants?
Have you yourself used technology in the classroom?	Was there an opportunity for them to use technology in their placement?
How about outside the classroom?	Was technology used in methods or other classes?
Skills acquired	
What kinds of opportunities did you have to learn about technology?	Were there classes available, outside learning opportunities, one on one sessions with teachers or students? Follow up with asking about how opportunities were or were not taken advantage of.
Have you picked up some new technology skills or activities you might use with kids?	What was gained?
Are there things which you could do at the beginning of the semester which you now feel more comfortable with?	Integration, improvement of existing skills.
How will learning [*indicate what has been acquired*] help you as a teacher?	What is the place of the acquired skills?
Beliefs	
At the beginning of the semester, you had mentioned that computers might be best used [in xxx] [to yyy]. How do you feel about that now?	Revisit earlier statements, look for reflections on them, changes.
What do you think some of the best uses of technology might be?	Vision of the future. Is it informed by what the intern has seen?
Are there drawbacks to the use of technology?	Does it get in the way of instruction? Hurt kids? Cost too much money?
What might it mean to be an advanced technology using teacher? What would such a person know how to do? What might she do?	Has what the intern has seen in the classroom shaped what she believes the goals of using technology to be?

Transcription

Interview times ranged between 35 minutes and 75 minutes. Audio tapes were transcribed word for word, including non-word utterances. All transcription was completed by the interviewer in order to facilitate inferences about context. Where necessary and possible, context interpretations of non-word utterances were included in brackets in the transcripts (i.e. "mmhm" [yes]). Most of the interviews took place in a small conference room, resulting in a high quality of audio tapes. Very few—less than a dozen in the entire first round transcripts—utterances were unintelligible. The "Descriptive statistics" subsection of the results section gives detailed information about the lengths of the transcripts, as well as the distributions of responses among the coding categories which were developed to analyze the transcripts.

Follow-up to interviews

To try to elicit participants' perspectives on significant themes in the interviews, completed transcripts were returned to the participants, with each participant receiving a copy of her own transcripts. Participants were asked to complete two tasks. In the first, they were directed to

> Highlight (with a highlighter or pen or pencil) parts of the interview which you think were especially important. In the margin, jot down why you thought that part was important.

The second task was to address the following two questions in light of their interview experiences:

> What do you wish you had gotten a chance to say about the role of computer-based technology in education that you didn't, either because it didn't occur to you at the time or because there wasn't an opportunity in the interview?
>
> In a paragraph or so, tell me what you believe the role of computer-based technology ought to be in k12 education.

With a few exceptions in response to the first task, participants highlighted a variety of selections in the transcripts; their marginal annotations were evidence that they took the task seriously and thoughtfully. The second task yielded much less useful data. Though some participants crafted reflective answers, most gave very brief answers or responded that they felt they had adequate opportunity to respond in the interview.

Coding of interview and follow-up data

Transcribed interviews were coded using methods recommended by Bogdan and Biklen (1992). As interviews were transcribed, a process known as "bootstrapping" was employed; significant comments and emerging themes were recorded in a database. These became the basis for the coding structure. The compiled list of emerging themes were compared with each other, with redundant themes merged. The remaining 84 codes arose from the bootstrapping process. Codes which seemed to touch on similar themes were grouped together into categories. As with the codes themselves, each category was compared with all other categories, and where possible, categories which overlapped significantly were compressed. This process yielded the following eight categories:

1. Background information (12 subcategories). This first category contained responses which were not in any sense beliefs. However, information about participants' background helped to shed light on the formation of their beliefs, so these statements were coded.

2. Social dynamics of computer-based technology (14 subcategories). Responses in this category concerned the general societal effects of computers. For instance, a number of participants believed that computers were enlarging the gap between rich and poor.

3. Computers and curriculum (7 subcategories). Participants were asked about the role of computer-based technology in various curricular settings. Statements which dealt with how computers might play a part in English and other subject areas were coded in this category.

4. Computers as used by teachers (8 subcategories). Often, participants commented on how computers might be used by teachers, both when thinking of specific instances they had seen and more generally when discussing positive uses of computer by teachers in the abstract.

5. Computers as used by students (17 subcategories). As with the category above, participants talked about how students might use computers in the classroom, as well as about specific cases of students' use of computers.

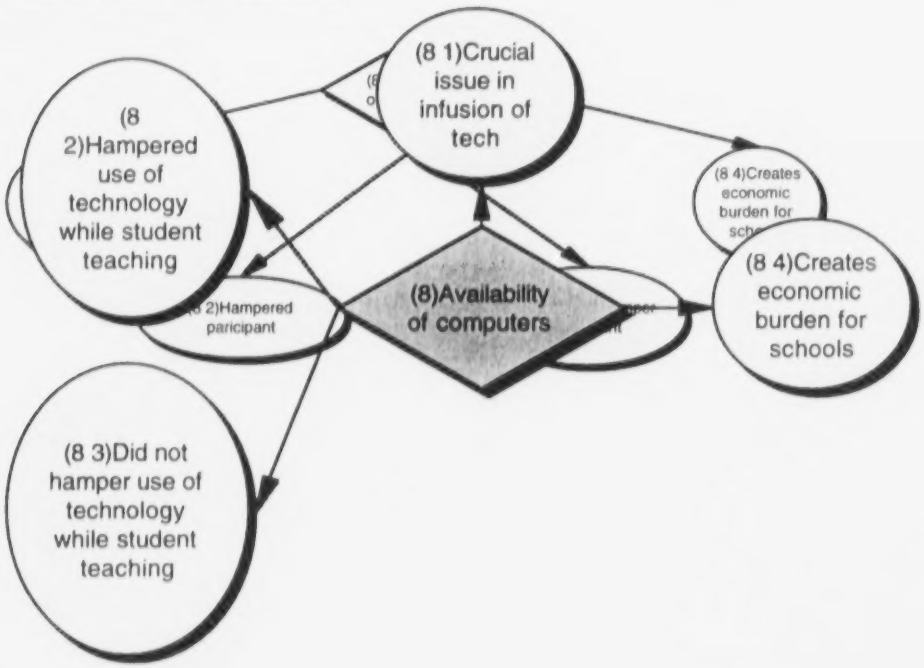
6. Learning about using computers (10 subcategories). In this category and the category below, participants considered their own use of computers. The category of "learning about using computers" was more process oriented, concerned with how skills and knowledge were acquired by participants.

7. Knowing about using computers (12 subcategories). Less process oriented than the category above, statements in this category referred to stable knowledge states.

8. Availability of computers (4 subcategories). None of the questions in either interview protocol asks participants to comment directly on the availability of technology as a factor in its use. However, every participant mentioned concerns related to the availability of technology and the resultant effect on their ability to incorporate computer-based-technology activities in their teaching.

After categorizing the codes, a complete index tree was created. The index tree contained all of the codes in a branching structure. Figure 2 is a representation of the index tree of category 8, 'availability of computers.'

Figure 2: Coding tree example


(8 1)Crucial issue in infusion of tech
(8 2)Hampered use of technology while student teaching
(8 4)Creates economic burden for
(8 4)Creates economic burden for schools
(8)Availability of computers
(8 3)Did not hamper use of technology while student teaching

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I used QSR NUDIST to code the transcripts. This software is designed specifically for coding and analysis of text documents. First and second round interview transcripts were converted to text documents and imported into the NUDIST environment. The coding hierarchy was entered into the system as well. A paper in which the analytical and methodological implications of using NUDIST are considered contains a more detailed examination of the use of this software (Margerum-Leys et al., 1999).

Using the complete index tree with its eight major branches and over 100 sub-branches, the 17 interview transcripts which comprise the data of this study were coded. After all of the transcripts were coded, codes which captured very few responses were combined with other codes. Even after reduction, though, over 80 codes remained. Appendix A shows the final coding hierarchy, represented as a concept map.

Coding and analysis of the transcripts followed verbal analysis coding, a method suggested by Chi (1997), which formally represents a researcher's subjective impression of the data, combined with an analysis which examines the frequency with which items identified as fitting the formal pattern occur. In this study, the complex coding tree represents my subjective picture of the data. By using NUDIST, I was able to map the 13,000 lines of transcribed material onto the coding tree, and examine the data for frequency patterns within and across codes and categories.

Results

The approximately three month span between the first and second round interviews was an intense period for the participants in this study. Each teacher education student worked in a middle or high school two days a week. This effort included a 40 minute commute each way and a full day in the school, shadowing teachers and students, teaching, observing a variety of teachers, visiting schools, and generally getting a feel for the rhythm of the public school. Two days per week, teacher education students participated in a two to three hour seminar after a full day at their school placement; they also enrolled in classes at the University. Average enrollment for participants in this study was 12 to 15 credit hours of graduate classes in addition to the school placement; a full work load which stretched their time thin. Graduate classes for most participants included a three credit teaching methods class and a three credit class in their subject area but outside of education.

One consequence of this hectic schedule was that the participants reported that acquiring technology skills was pushed down their priority list. As has been mentioned, few of the participants were able to take part in the Friday morning educational technology practicum.

Along with a press of time, teacher education students were impeded by a lack of facilities at their respective schools. Only two of the participants, Soles and Sims, had access to a modern computer lab of any kind. Only one of these (Sims' school) had a computer lab which was Internet-connected. At the other schools, computer equipment was either outdated, unavailable to English teachers, or distributed in such a way as to make it impractical for participants to use technology-infused activities with their classes.

This study was designed to examine changes in participants' beliefs about technology during their fall teacher education experience, with changes possibly tied to technology education experiences encountered during the study time period. This purpose was thwarted by the impediments described above. Still, there were interesting developments in the participants' beliefs about technology in school settings.

Participants' beliefs regarding computers and other technology are reported using classifications drawn from the coding structure. In each category from the coding structure, I report the number of lines in the transcripts devoted to responses in that category. I also report trends in participants'

responses within each of the categories, choosing representative instances of these trends to illustrate participants' statements. These results are compared and contrasted with relevant literature to show how this study might be placed in relation to the literature on technology and teacher education. Implications of study results for teacher education are discussed in the following section.

Descriptive Statistics

The average length of the first interview transcripts was 812 lines (range 505 to 1162 lines), yielding 7,304 lines of transcripts. The second interviews, which contained far less background information, were generally shorter. Second round interview transcripts ranged from 467 to 718 lines, with one outlier. Stout's second round interview was almost twice as long as the next longest second round interview—1,426 lines compared with Needham's 718 lines. Second round interview transcripts totaled 5,609 lines of dialogue; interviews other than Stout's averaged 598 lines in length. Stout's interview was longer because of his discourse style; he often answered interview questions in a topic-associative way, moving from topic to topic in ways which seemed oblique.

To give a more complete representation of the distribution of transcript text, Table 4 shows the length in lines of each participant's transcripts:

Table 4: Transcript lengths in lines

Participant	Interview 1	Interview 2
Aaron Sims	542	529
Amira Hendry	1142	495
Barbara Greenwalt	1092	654
Beth Soles	747	619
Byron Karabotsos	587	--
Cheryl Mallery	770	467
Dawn Needham	505	718
Gary Barnard	757	701
Quentin Stout	1162	1426
Average:	812	701

Figure 3 shows the number of lines of each transcript devoted to each belief category. Note that because some lines of the transcript were double coded (a line on curriculum may contain information relevant to social dynamics, for instance), totaling the number of lines per category does not equal the total number of lines of transcript.

Figure 3: Lines of transcript per belief category

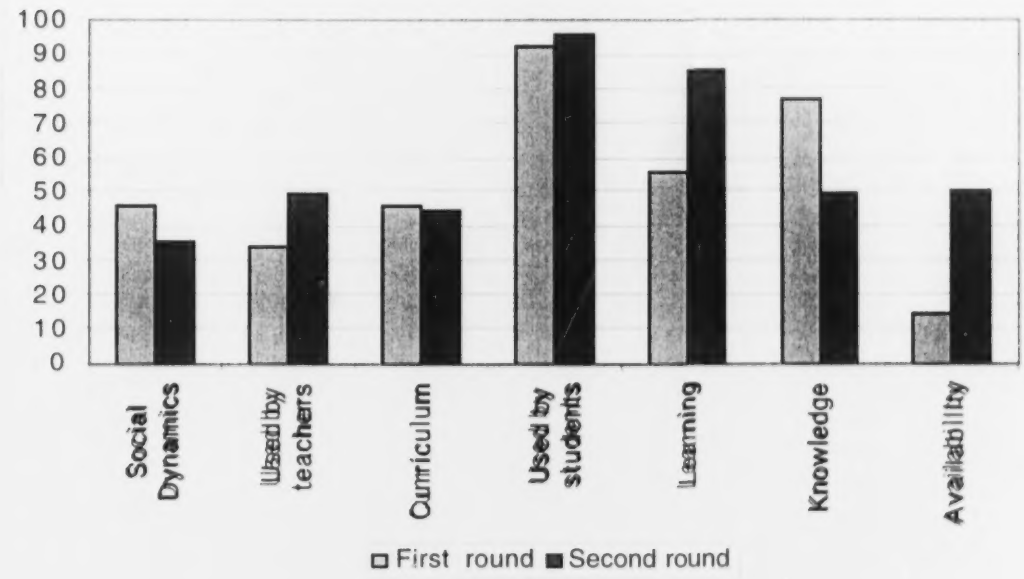
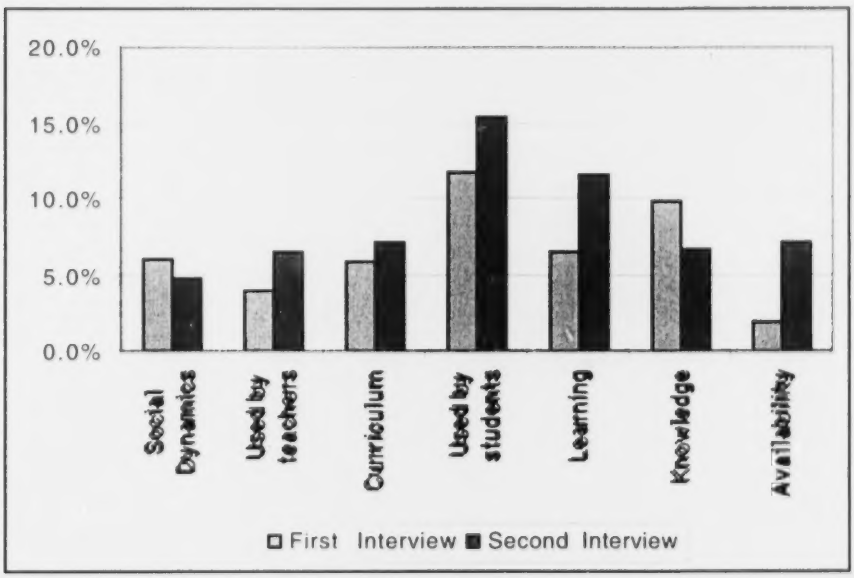


Figure 4 shows the balance among the coding categories for the first and second interviews as percentages of the transcript devoted to each category. Because background information is not reported in the same way as participants' beliefs and interviewer text was not considered a study result, background information and interviewer text are not shown in Figure 4. For a more detailed description, Appendix B shows the percentage of text lines for each participant for the coding categories, including background information and interviewer text.

Figure 4: Percentage of beliefs categories for the entire sample



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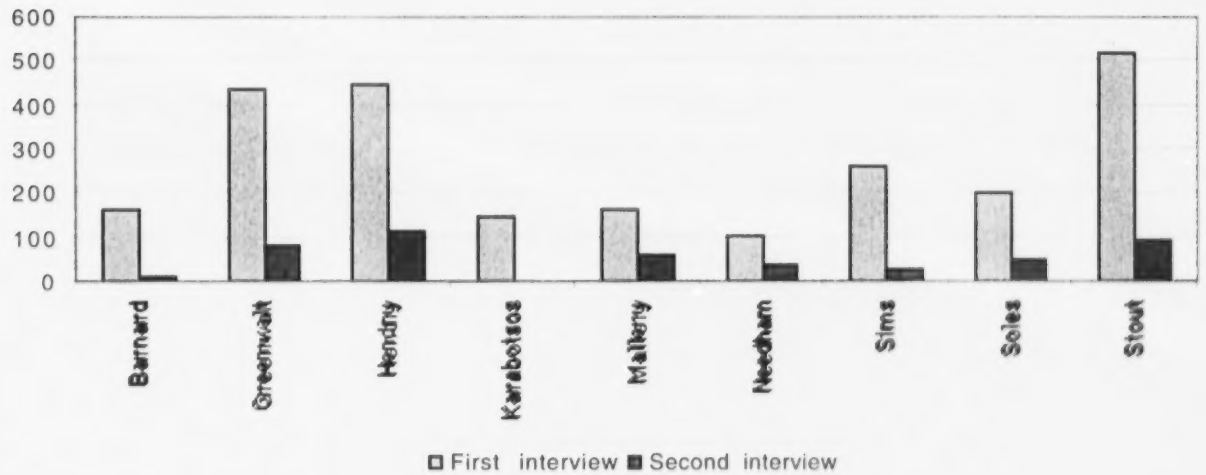
At the beginning of each category below, I present a histogram of participants' responses in that category for both the first and second round interviews. The unit for these figures is a line of transcript text. Each histogram gives an overview of the distribution of beliefs within the category, allowing comparisons between participants and across interviews. This data is not meant to imply statistical significance. Rather, it gives the reader a general impression of which participants contributed the most to each category.

Background Information

Figure 5: Background information, lines per participant per transcript



A large proportion—approximately one third—of the first round interview transcripts consisted of information about students' background experiences with technology and in educational settings. The number of lines of the first round transcripts relating to background averaged 272 (range 101 to 519). As Figure 5 shows, the second round interviews had a much smaller amount of material devoted to background—an average of 60 lines per transcript (range 10 to 117 lines). Only three of the eight second-round participants (Hendry, Mallery, and Stout) devoted more than ten percent of the interview to background information.

Background information was used in this study to give context to participants' beliefs. Having a context within which to place participants' beliefs is helpful in interpreting the results in the remaining categories. Knowledge of participants' various backgrounds—which include substitute teaching, college-level writing instruction, private school teaching, full time child care employment, and entertainment industry background, among other experiences—provided connections between their beliefs and these experiences.

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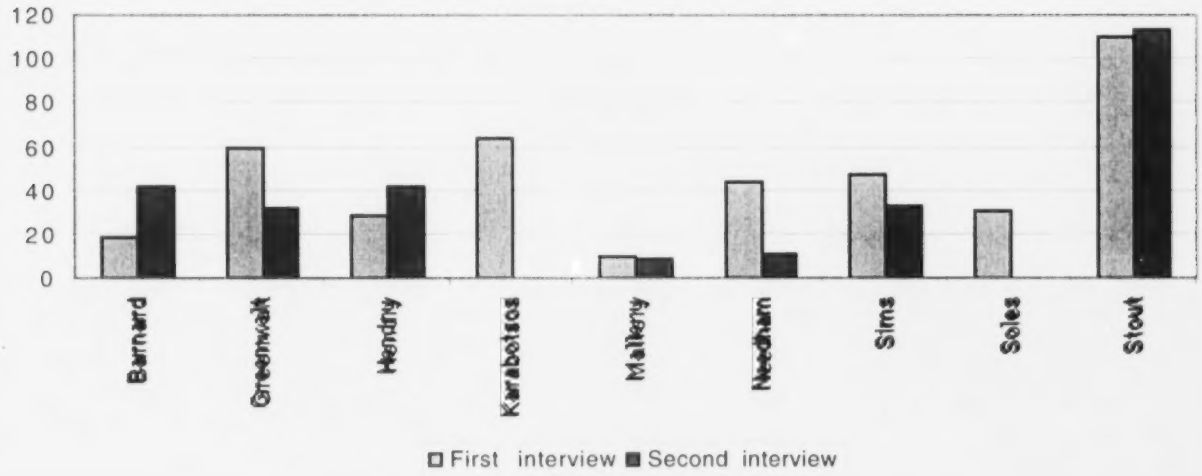
Social Dynamics

Figure 6: Social dynamics, lines per participant per transcript



Responses in this category refer to how technology use or the lack of it affects society as a whole. As Figure 6 shows, participants commented relatively infrequently about how technology might affect social dynamics, either within personal relationships or in society at large. Responses related to the social impact of computers and technology accounted for an average of 46 lines (range 10 to 110) of the first interview, dropping to an average of 35 lines (range 0 to 113) in the second interview series. The low amount of response in this category may be related to the interview protocols, though the interviews contain questions which could have elicited responses related to the role of technology in society. For instance, the open-ended question "Are there drawbacks to the use of technology?" in the second interview could have elicited responses which considered effects on society.

Stout commented more frequently about social dynamics than did the other participants. Examination of percentages of transcript dedicated to social dynamics shows that Stout had a larger percentage of transcript material dedicated to social dynamics than any other participant who completed the study, but the difference in proportion (9.1% versus 7.5% for the next-highest participant proportionally, Sims) was much less striking than the difference in number of lines (112 versus 46 for the next-highest participant by number of lines, Greenwalt).

When participants did talk about social impact, they most frequently commented on the possibility that technology sustains or increases the gap between rich and poor.

Four of the eight participants (Soles, Needham, Barnard, and Stout) made reference to the role technology might play in continuing socioeconomic disparity. They generally cast this as a situation in which some segments of society are moving forward while other segments remain in place, locked out of the power available to those with access. Stout put it this way:

> I think, you know, politically speaking I think it creates, it widens the gap between the poor and the rich. Because now information is as important as money. And the more, ... it's always been known, information and knowledge is power, but, this puts such an

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> emphasis on information. That those people who have no access, and there's just too many people that have no access... (Stout, Second interview)

The belief that technology has the capacity to maintain or increase the gap between rich and poor is one which is echoed in the popular media and in national politics. President Clinton (Clinton, 1998), refers to this gap as the "digital divide," noting that "We know from hard experience that unequal education hardens into unequal prospects. We know the Information Age will accelerate this trend." The President's Committee of Advisors on Science and Technology report (President's committee of advisors on science and technology, 1997) also makes reference to potential inequities related to educational technology, stating that they "have the potential to either ameliorate or exacerbate the growing gulf between advantaged and disadvantaged Americans" (p. 120)

One participant (Sims) saw technology in a generally negative light in terms of its possible effects on society. Interestingly, he had mixed feelings toward technology. Early in the second interview, this exchange occurred:

> Margerum-Leys: What about things that, um, computer-based technologies are used for in schools that might be negative? What are the downsides of using computer-based technologies?
>
> Sims: [Long pause] [sigh, clears throat] Boy, you stumped me. (Sims, Second interview)

Later in the same interview, in a long response to a question about his feelings about whether his skills are sufficient to use technology in his teaching, Sims replies in part:

> Sims: I don't know, I have a grudge against technology. I think that, I don't know, I mean, it's just, ... I don't know, nostalgia or, atavism, or you know, whatever it is. I associate that kind of technology with the way things are moving in the world, whatever that means.
>
> Margerum-Leys: What does that mean?
>
> Sims: What does it mean? It means that, that, um, [sigh] I don't know, it means that kids are shootin' kids in the schools in Kentucky, you know? It means that, um, that inner cities across the nation are kind of falling apart. It means that, that um, the gap between the haves and the have nots are... getting bigger and bigger and it means that, that kids I think as a rule, have to grow up faster and have to eat more, crap than they had to, and, ... those are the kinds of things that I think about. ... and now they have to, like, use computers also, because like, reading and writing wasn't good enough or whatever, or it can, or it will continue not to be good enough, because what this world is about is about information and power and money and, and, computers are the key to information and power and money. And... I think I see like the spiritual side of, of humanity like dying. Dying a slow death. And... that there's no room any more for, for, the artist or for the poet or, whatever. That kind of stuff. And, and I see that computers are a part of that. (Sims, Second interview)

This view of technology as a danger to society is echoed in literature which discusses culture and technology (Kling, 1996; Postman, 1993). For Kling, there is a danger in equating technological and social progress. The ability to access more information faster is touted by proponents of technology, but often without consideration of the economic cost of acquiring that technology. Kling references a newspaper article which made glowing predictions about a couple in 1999 living in a 'smart house', but which did not mention how difficult it was for an average couple in Los

Angeles to buy a 'stupid house'. In building his argument, Kling makes specific reference to the possibility that technology widens the gap between rich and poor.

Postman's argument is less economic in nature, more concerned with the implicit decisions that are made when adopting more technological ways of meeting real and perceived needs. His stance is similar in substance and at times in tone to Sims' responses above. Postman worries that as technology is adopted throughout society, people's lives will become so complex as to not be understandable. The result will be that people will serve technology, a reversal of the traditional and desirable relationship. Fullan (Fullan, 1993) echoes Postman's position, noting that educational systems are so complex that causality is impossible to predict and that ends cannot be determined from means.

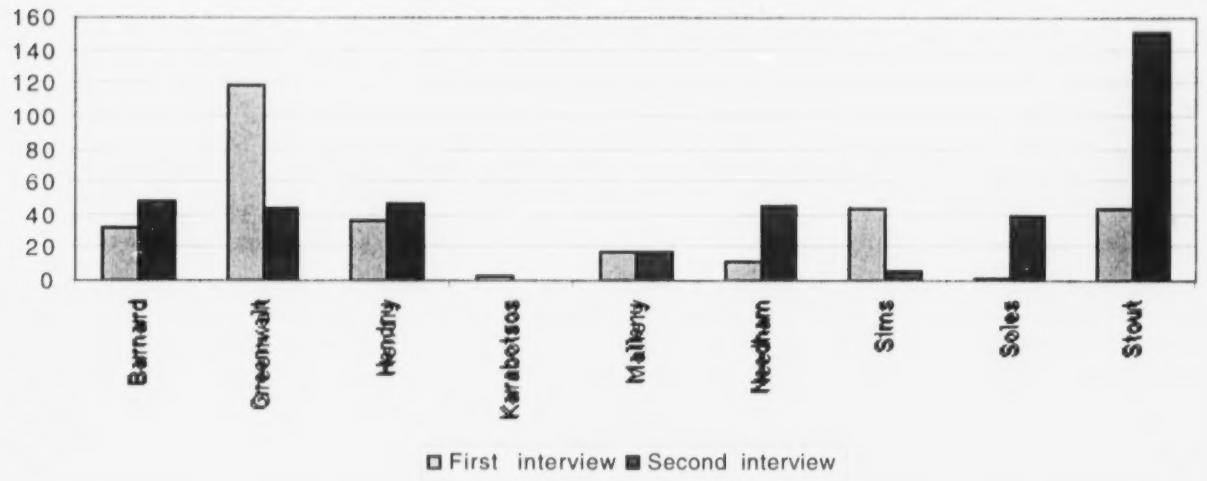
There is also a literature which questions the societal impact of using computers in education (Bork, 1991; Oppenheimer, 1997). Bork's argument is essentially historical. Implementation of technology, especially computer-based technology, has repeatedly followed a cycle of implementation in which teaching and learning considerations are placed behind the desire to simply acquire hardware. The end result, Bork argues, is that technology has little effect on education other than to be a drain on limited resources. Oppenheimer's argument is in some ways similar, though he builds it on a view of classroom time as a zero sum and focuses his criticism primarily on computer use in the elementary grades. He laments the demise of enriching activities such as physical education, music, and field trips in favor of computer use.

The contrast between this literature and works supportive of computer use in education (Negroponte, 1995; Zeni, 1994) is striking. Negroponte combines constructivist ideals with a populist appeal for computers in education as "Hard Fun" (p. 196). Zeni's work focuses on the computer as a vital tool in a whole language writing curriculum. Among Zeni's claims is that "only at the computer (preferably one with a spelling checker) is it realistic to push a very low-skilled writer through repeated editing to a clean copy" (p. 264).

Schofield (1995) discusses this contrast, concluding that for researchers in educational technology as well as teachers, a middle path which strikes a cautious optimism about technology's effect may be appropriate. With few exceptions, this middle path was where participants' responses on the impact of computers on society fell.

Computers as Used by Teachers

Figure 7: Computers as used by teachers, lines per participant per transcript



One result of the their experience in school settings was that participants had more to say about computer and other technology use by teachers in the second interview than they did in the first interview. Seven percent (range one to eleven percent) of the second interview transcripts was related to this category, up from four percent (range zero to eleven percent) in the first interview transcripts. In terms of numbers of lines, the jump was from an average of 35 lines (range 2 to 119) in the first interview to 50 (range 6 to 151) lines in the second, despite the average total length of the second round interviews being shorter.

Two participants (Mallery and Stout) saw technology use by teachers as related to a general progressive approach to education by those teachers. For them, use of technology was seen as one of the things progressive teachers do. Mallery observed that

> If you're very progressive, you're a very technology oriented person, then you're going to ...have the kids do things in class with computers. Take them down to the lab, have them write, use the Internet, have them go out and find stuff. (Mallery, Second interview)

A link between technology and educational reform is a common perception, but one which does not necessarily exist in educational practice. Means (1994) refutes the idea that technology and progressive educational ideals are necessarily linked, giving examples of technology which supports the status quo.

Other researchers do link the use of technology to progressive education. For the Project-Based Science (PBS) group, for instance, technology use is a key component of project-based education (Krajcik, Blumenfeld, Marx & Soloway, 1994), which in turn is a progressive educational reform effort. Other reform-oriented educational efforts also make use of technology. One Sky, Many Voices (Lee, Songer & Samson, 1998), anchored instruction in the Jasper Woodbury series (Cognition and Technology Group at Vanderbilt, 1996), and the Collaborative Visualization (CoVis) (Pea, Gomez & Edelson, 1995) project are all examples of projects which use computer-based technology to help further their educational reform efforts.

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Among the current study participants, traditional teaching activities were the focus of their beliefs about the use of computers by teachers. The most commonly talked-about use of computers by teachers was information and resource gathering in support of conventional classroom teaching practices. In this passage Greenwalt discussed using the Web to gather materials for a classroom bulletin board:

> The things that fascinate me about it is, that you can get, these great pictures, that you might not be able to otherwise get in the classroom. ...because, all, the only pictures that teachers have in their classroom are the things that they have up on their bulletin boards.... You know, the school isn't just like throwing money at you to buy new pictures for your classroom to put up. (Greenwalt, First interview)

When asked what an "advanced computer using teacher" would be able to do, information gathering figured into Mallery's appraisal: "They'd probably be familiar with how to search on the Internet" (Mallery, First interview)

Keeping student assessment records through the use of grading software was mentioned by all participants in either the first or second round interviews. This may have been related to participants' exposure to grading software during the summer program. Additionally, four of the participants (Sims, Hendry, Soles, Needham) specifically mentioned during the second interview that their co-operating teacher used grading software. The exchange below was typical of the context in which gradekeeping programs were referred to:

> Margerum-Leys: In the best case, what would teachers do with computers?
>
> Needham: Gradebooks. Uh, you know, even, even word processing. Just to cut and paste things, from other documents. (Needham, Second interview)

It may be that the benefits of using gradekeeping software are easy for teacher education students to see and that such software can be integrated into participants' existing framework for teaching and learning. Given participants' stated concern with the availability of technology for use in their classrooms, it may also be the case that participants viewed gradekeeping software as an appropriate use in a single-computer, non-Internet-connected classroom.

In order for teachers to use technology in their teaching, the literature on technology and teaching strongly recommends increased teacher development (Blanchard, 1994; Collis, 1994; Office of Technology Assessment, 1995). Without teacher preparation, efforts to implement technology in the classroom are unlikely to be successful. Blanchard calls teacher development "a linchpin that helps to define many of the other issues." (Blanchard, 1994, p. 193)

Echoing the literature, participants in the current study viewed teacher development as vital to successful computer use by teachers. Seven of the nine participants mentioned the importance of teacher development, even though none of the questions on either interview protocol asked directly about this topic. Participants generally viewed the lack of teacher development in technology as being a deficiency which would keep computer-based activities from being implemented by themselves or by other teachers they observed. Mallery, in highlighting sections of the transcript which seemed especially noteworthy to her, selected the following passage:

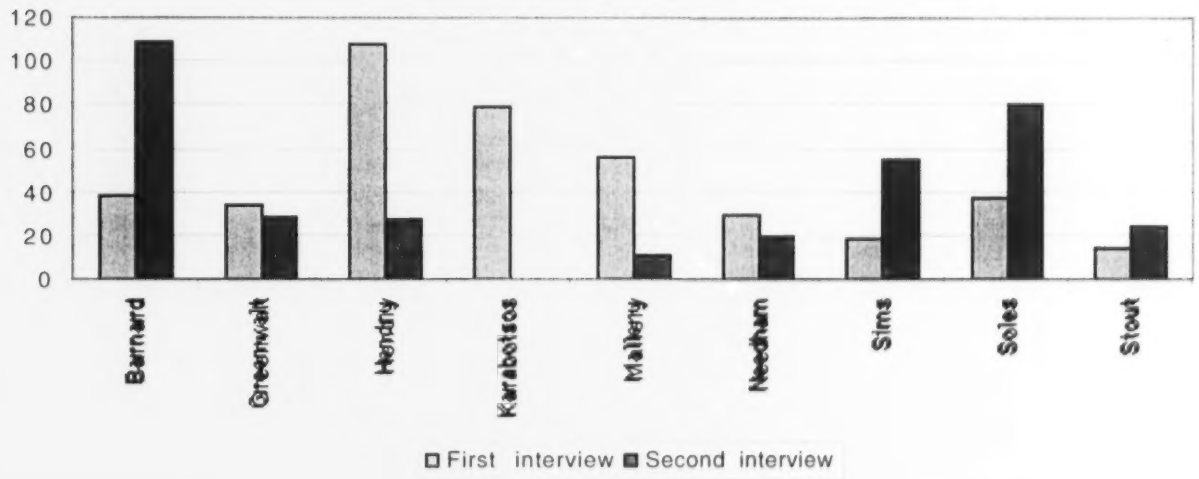
> I need to have a working knowledge of, of it so that I can, if they [students] say 'how do you do this? How do you print? How do I put a box in this part of the screen?' [pause] I need to be able to say 'well, you do this.' I think to be a credible teacher you have to know what you're doing. (Mallery, First interview)

From the follow-up, Mallery's note in the margin next to this passage read "*very important. Refers to teaching in general."

I discuss teacher learning about technology in a later subsection, but the link between participant comments regarding teachers using computers and teacher development was very strong; in sections of the transcript where they discuss how teachers use computers, it was very common for participants to also mention teacher professional development.

Computers and Curriculum

Figure 8: Computers and curriculum, lines per participant per transcript



Though the percentage of transcripts devoted to curriculum issues was slightly higher in the second interview (seven percent versus six percent in the first interview), the number of lines of text related to this area was essentially identical (an average of forty-six lines per transcript in the first interview versus forty-five in the second).

Participants were asked to think about how computer-based technology would fit into the English curriculum and to compare that with how computer-based technology would fit into the curricula of other subject areas. They were also asked if they felt that computer-based technology was better suited to some subject areas than to others.

When asked how computer-based technology might be used in the English curriculum, participants generally focused on three areas: Writing, project creation, and information gathering. Drill and practice software, a fourth way of using computer-based technology as part of the curriculum, was mentioned by several of the participants, but generally in the context of beliefs about subject areas other than English.

Writing. Participants' responses on writing were almost entirely centered around the use of word processing software. Only one participant mentioned any software for writing other than word processing software; Mallery recounted a positive experience with using a chat program in a writing class she taught at the college level. Four participants (Hendry, Soles, Barnard, and Stout) stated that using word processing software would improve their students' writing. Improvement was defined variously in mechanical terms (improving spelling by using spell checking), increased

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revision over hand writing, increased fluency as measured by writing output, and pride of authorship through more attractive looking finished products.

Three participants (Greenwalt, Karabotsos, and Mallery) expressed reservations about using word processing software, believing that students' writing might be adversely affected. These participants believed that word processing added a layer of complexity and distanced students from their writing, reducing their sense of ownership.

Project creation. Seven participants (Barnard, Greenwalt, Hendry, Karabotsos, Needham, Sims, Stout,) talked about project creation as part of the curriculum, generally in response to questions asking them to envision best uses of computer-based technology. Participants described interdisciplinary projects in which the computer was used to author presentations as well as to track progress of projects. Greenwalt's statement exemplified this belief:

> I think, in science classes I know that they're doing that project at Franklin High, where they…go out and actually do tests on the… stream or something, that's near the school that they go to, and they do all these kind of ecosystems, it's really integrated? And I've heard people talk about it before. And that sounds like a pretty good idea. Like the computers are a tool that is used every day in the classroom as part of like, you know, everything from taking notes on them to figuring out mathematical results on the different tests that they do, to keeping records. (Greenwalt, First interview)

Only one participant, Hendry, discussed a project that she herself had implemented in the classroom. All of the other participants drew their beliefs about using projects as part of the curriculum from their experience as a K-12 student, projects they had been exposed to in methods classes or at conferences, or activities that they had heard about informally from friends or colleagues at their school site.

Information gathering. When participants responded to questions about how computers might be incorporated into the curriculum, information gathering was mentioned often. Information gathering was also mentioned in the context of "best-practice" questions, as well as in response to questions about what participants had seen students doing in classrooms they had visited or, in a few cases, worked in. With every participant except Needham having responses in this area, information gathering as part of the curriculum was one of the most often-mentioned areas.

Responses coded as information gathering in the context of curriculum commonly made reference to students seeking factual information for use in reports or presentations. Participants viewed use of the computer for information gathering as paralleling what students might traditionally do in a school library or as analogous to the use of reference books such as encyclopedias or atlases. Information gathering was viewed positively by all of the participants, with statements such as the following being typical:

> Not only that, they're going to learn how to research [snaps fingers three times] like this. They're going to learn how to research material that's right here, right now. (Stout, Second interview)

Some sources in the literature (Greene, Devlin, Cannata & Gomez, 1990; Wallace & Kupperman, 1997) are cautious about the difficulty students have effectively searching for information. Greene's research showed that in searches of data sets, subjects were unable to efficiently find relevant information. Wallace's study showed that middle school students had difficulty dealing with information found; issues of ownership, relevance, and reliability were challenging for students. Participants in this study made no mention of these difficulties for students, though a few did express frustration with their own inability to find information on the World Wide Web.

Drill and practice software. When participants were asked to think about how computer-based technology might be used in the curricula of subject areas other than English, some (Barnard, Mallery, Sims, and Soles) made reference to drill and practice software as being a useful component. The juxtaposition of the computer as a creation tool in English (writing and project creation) and a drill and practice tool in other subjects is shown clearly in this segment:

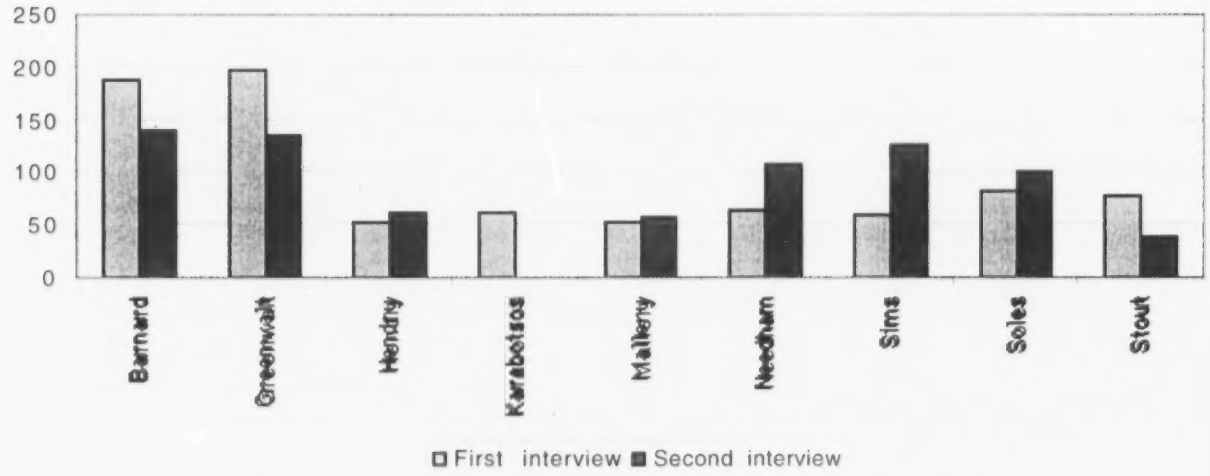
> But I think that, definitely, the word processing is important for language arts or communication arts classroom, more so than in other classrooms....For math, there are wonderful, wonderful programs, too. I know that. I know that, they help out at least in elementary level, there are lots of drill and practice things that are a lot of fun. And the kids learn, and they get a lot out of it. (Soles, Second interview)

Although drill and practice software is often used in schools, recent research development suggests more constructive use through the design of technology as cognitive tools (Chipman, 1993). One possible explanation for participants' focusing on writing and information gathering within English and mentioning drill and practice in conjunction with other subjects is that their experiences and thinking about technology in English is more recent than their experiences and thinking about technology in other subject areas. When they talked about technology use in English, they frequently cited methods classes, things they had seen at conferences, and conjectures about what might work in the classrooms in which they were placed. Technology use in other subject areas was often mixed in with background information such as recollections of activities participants had been exposed to in their own K-12 schooling.

An additional interpretation would be that participants have a relatively complex understanding of English, but only a limited view of other subject areas. This interpretation is supported by participants' statements about subject areas other than English. Statements such as "science to me feels very factual" (Hendry, First interview) and "math provides me with kind of an externalized structure. Because, at least the way we teach it, there's not really that much room for, um, the subjective" (Karabotsos, First interview) support the interpretation that participants' less complete understandings of subject areas other than English may be connected to their thinking about computer-based technology in the curriculum.

Computers as Used by Students

Figure 9: Computers as used by students, lines per participant per transcript



The average amount of text relating to computers as used by student in each transcript was relatively stable when comparing the first round of interviews to the second. In the first round of interviews, participants devoted an average of 93 lines (range 52 to 197) to this area. The second round interviews contained an average of 96 lines (range 40 to 141) of text related to the use of computers by students. Due to the structure of the interview protocols, there were more responses regarding computers as used by students than responses within any other category besides background information. As was the case with every other category, participants were generally positive about the use of computer-based technology by students.

The most common positive beliefs about technology concerned technology as a society-wide trend with which students needed to keep up, positive motivational effects of using computers, the value of computer games, enrichment through interaction with other students, and the belief that all students gain from using computers. Negative responses included a belief on the part of a few participants that activities which included computer use allowed students to do less thinking and the observation that computer use in the classroom was distracting. One area in which there were positive and negative responses was the impact that technology in the classroom might have on the relationship between students and teachers.

Technology as an important trend in society. Responses coded in the "Social Dynamics" category had to do with the societal effects of computer and technology use; computer use or non-use has an impact on society. In contrast, responses coded as "technology as an important trend in society" under "Computers as used by students" were concerned with the motivation for using computers in schools. Participants were clearly influenced by their own postsecondary experiences and by the media when they thought about why students might use computer-based technology and what they might do with it. By far the most common justification given for using computers in the classroom was that students need to use computers in order to stay current in society. Every participant mentioned this need; several emphasized it as being of paramount importance. Cheryl Mallery's comments reflected the general feeling of participants:

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> I don't see how they can be at all prepared for the future if they go through school and they do not encounter technology. Because... even now, if you...don't know how to use a computer, if you don't know how things work. If you can't go to a library, and use an on-line directory, you're seriously inhibited. ...there are so many restrictions. You can't even work in most stores. You can't even have that kind of job, [be]cause most cash registers now are computerized. You have to know how to use that. So definitely. They all have to take it. For me it's not a question of wanting or not wanting. (Mallery, First interview)

The importance of using technology in K-12 classrooms because it is a trend in wider society is reflected in the rhetoric of governmental documents and speeches (Clinton, 1998; President's committee of advisors on science and technology, 1997). In an increasingly global economy, exposure to the use of technology is vital for K-12 students.

Cuban (1986), however, cautions that widespread use of a technological innovation in society does not necessarily mean that schools should incorporate that innovation into the educational setting. Citing historical educational sources which predicted significant impact from radio receivers, film strips, and television, Cuban argues that technologies which are important to society do not always need to be used in education.

Positive motivational effects. Seven of the participants (Barnard, Greenwalt, Karabotsos, Mallery, Sims, and Soles) remarked on the motivational effects of using computers. Participants, with one exception, believed that computer use led students to participate more, complete more work, undertake more revisions of their writing, and enjoy classroom activities more.

For some participants, these positive changes were the result of novelty. Students were more willing to participate and remained engaged longer because using the computers was an unusual experience in their educational lives. The novelty might, in the future, wear off, but for now using the computer was new enough that students were stimulated by the out-of-the-ordinary nature of using computers in the classroom.

For other participants, the positive changes they observed were affective; students enjoyed using the computers. In the second interview Soles said:

> There are kids who really thrive on technology. I mean, they live for technology; there are kids who bring in things that they've done on their computers, and you know they'd spent hours, and just, an ungodly amount of time on it, and they were thrilled with it and they love it. And that would obviously be a good motivator and something to keep their interest. (Soles, Second interview)

Participants stated the benefits of positive motivation of students in tangible terms, especially in the second round of interviews. Participants who were able to observe students using computers in their school activities reported that they believed computer use led to increased motivation as evidenced by a higher percentage of work turned in and more time on task.

Only one participant believed that computer use had a detrimental effect on motivation. Sims indicated that he believed that human contact was much more motivating than positive feedback from a computer. The other participants considered use of the computer separately from interaction with a teacher. When participants commented about the positive motivational value of computer use, they responded in terms of tool use by students, primarily in using word processing software, with increased motivation the result of novelty, perceived increase in efficiency, or perceived increase in quality of the product of their tool use. Sims saw the computer in terms of an additional source of feedback, finding computer-student interaction less motivating than teacher-student interaction. Here is how he phrased his response:

> I don't think there's any weight behind a computer saying 'great job!' compared to a real live person who makes eye contact when saying that, or pats the student on the back....there's that contact there that's very real that's probably not perceived so much as real when the student is with a computer. (Sims, First interview)

Value of computer games. Closely intertwined with motivation, though less frequently cited, were beliefs about using the computer to play games. When participants talked about students playing computer games, they often mentioned motivational aspects as part of their observations about students playing games on the computer. Sometimes using the computer to play games was seen as positive, even if not much content learning was taking place:

> You know, even if it's just to play some, some silly grammar games or math games... I don't think those kind of games like Math Blaster and stuff like that even have as much subject matter learning potential because it's just a game.... But just for them to be comfortable, not scared by the computers and see that they're fun. (Barnard, Second interview)

For other participants, playing computer games was not educationally advantageous. In this passage, Soles relates her impression of students playing "Where in the world is Carmen San Diego?", a popular geography game:

> If it's just kids sitting there, I mean, yeah, after a while if the game really intrigues them, they might go look some other stuff up, but kids are not, kids do not leap out of their chair and run to the library to look things up. Generally speaking. It'd be nice if they did; it'd be nice if I did that. But I don't. (Soles, Second interview)

For Soles, playing the game did not offer enough motivation to cause her to want to search for any content not found within the game. Interestingly, she uses her own experience with playing the computer game to interpret how she believes students would experience the game.

Interaction with other students. Participants talked in very general terms about students using computers to interact with each other, usually in response to best-practice questions. There seemed to be a feeling that student-to-student interaction would offer some of the benefits that participants saw for themselves in using electronic mail. Perhaps not coincidentally, the only participant who talked in specific terms about student to student interaction was Sims, who was the only participant whose school site had an Internet-connected computer lab.

All students gain. In response to a question which asked if certain students were better suited to using computers than other students, five participants (Barnard, Greenwalt, Hendry, Mallery, and Stout) indicated that generally all students stood to gain from computer use of some kind, though most also indicated that there were factors which influenced how much benefit students would receive from using computers.

Where participants believed that some students would gain more from computer use than others, factors cited included prior experience in school or at home (Needham, Sims, Soles), age (Karabotsos, Mallery, Needham, Sims), gender (Greenwalt, Karabotsos) and learning difficulties such as attention deficit disorder (Karabotsos, Needham, Sims, Soles).

Prior experience in using computers was seen in a way portrayed in the famous song by jazz singer Billie Holiday (1956): "Those that's got, shall win/Those that don't, shall lose/So the Bible says/But it still is news". Students who had experience with using computers in the past stood to gain more than those who had not.

Participants who believed that age was a factor in how students would benefit from computer use were split on whether older or younger students would see more benefit. Mallery and Sims believed that younger students were more computer savvy simply from growing up in the current high-tech era. Mallery said:

> I think that the younger kids today are very computer literate. If they've been exposed to it. And I think younger kids pick up things faster. [Be]cause I'm a lot slower than I think some middle school kids are. (Mallery, Second interview)

Karabotsos and Needham saw computer use as more relevant to older students. Needham (First interview) said that "You may be able to introduce some things to older kids that you wouldn't want to expose younger kids to."

Two participants, Greenwalt and Karabotsos, saw computer use as more appealing to male students. Greenwalt, a woman, seemed amused at what she saw as a male pre-occupation with gadgets. Karabotsos, a man, believed that males could become obsessed with computers, but that was not necessarily a bad thing:

> Boys just get into it to the point where they are obsessed. And they spend so much time on it. And then they land some great job in the computer business. (Karabotsos, First interview)

Participants who talked about students with learning difficulties were split on whether computer use would be more beneficial to students with than it would be to students without learning difficulties. Needham and Sims felt that for students with difficulties, computers represented an additional challenge, while Karabotsos and Soles felt that computers could be a useful tool for these students.

Computer use may allow less student thinking. Two participants (Greenwalt and Barnard) wondered whether students might use the computer as a crutch, allowing them to do less thinking for themselves. Rather than "grappling with fundamental thought," students will "get lazy" (Barnard, First interview). He goes on to say:

> You know, I'm a product of the spell check....But when I write, man, I mean, I just let my fat fingers do the typing and I never took a keyboarding class, so, you know, first of all my technique's not good, and then my spelling is atrocious. But uh, spell check covers me. So, I mean in general I don't take the effort to learn the word....Is that good, is it bad? I mean, yes and no, I think it hinders you as a thinker to a certain degree. But, the reality is, I mean, this technology will be available to you and as long as you understand the concept, which I think most people don't, which I think that's where the problem lies, whatever concept it might be, um, you know, might as well take advantage of the technology. (Barnard, First interview)

Computer use is distracting in the classroom. Three participants (Karabotsos, Mallery, and Needham) related being in educational settings in which computers distracted students from paying attention to them in their role as teachers. Two of the three (Mallery and Needham) acknowledged that students' distraction might be caused by being more invested in the work they were doing with the computer than in what they as teachers were trying to tell the students. For these participants, the distracting nature of having computers in the classroom was something they needed to consider when planning, but might not necessarily be a problem.

The third participant who mentioned distraction (Karabotsos) had experienced students' distraction with computers in his work as a substitute teacher. For him, students being distracted by the computer was perceived as a problem: Distraction on the part of students represented a break in the

tight classroom order he felt obligated to maintain. As a substitute teacher, Karabotsos may have been less invested in the long term learning goals of the classroom and more invested in maintaining order.

Student-teacher relationship. Six participants (Barnard, Greenwalt, Hendry, Mallery, Sims, and Soles) expressed concern that computers in the classroom environment could change the relationship between teachers and students. These concerns were generally in response to questions asking about possible negatives to using computers in the classroom. One participant (Sims) worried that students would think that teachers were redundant. For the other participants who raised this issue, the concern was that teachers themselves would use computers as a way to not have to relate to their students. All of these participants compared computers with inappropriate use of VCRs; the technology could become a replacement for a relationship with a teacher. In this scenario, the computer was seen as another form of electronic babysitter, occupying class time so that the teacher did not have to interact with the students. Greenwalt's comments were representative of participants who expressed this belief:

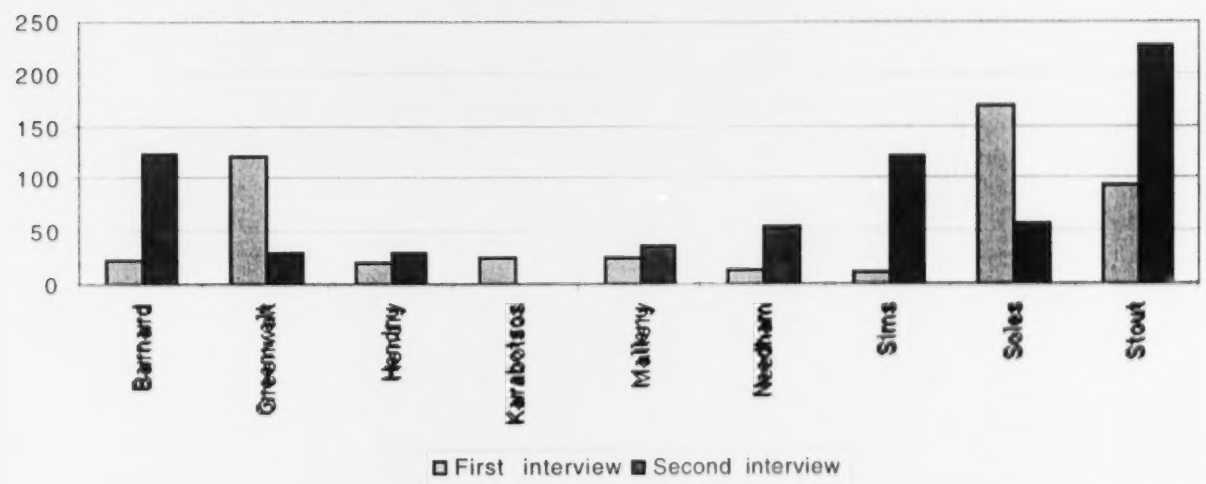
> The big thing is using the computer to teach the kids. Period. Sitting them in front of the computer and saying 'okay, now this is your lesson for the day, go through the lesson and use the little help-based thing on the computer, and maybe ask your classmates and whatever, and I might be around.' You know, because the computer shouldn't be there to replace the teacher. [Be]cause it can't do it. (Greenwalt, First interview)

Interaction, discussion, and follow-up to computer-based activities were seen by the participants as key to keeping student-teacher relationships strong. Barnard noted that:

> I think technology will always remain supplemental.... And I think that teachers that use technology just have to be cognizant of the fact that they shouldn't abuse it, and that it is their job to form relationships with the children. Because the computer certainly can't form a meaningful relationship with the kid. (Barnard, First interview)

Learning about Computers

Figure 10: Learning about computers, lines per participant per transcript



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Participants' statements which were coded in this category related to how they believed that they had learned and would learn about using computers and how, in general, people do and ought to learn about using computers. In the first round interviews, these responses averaged 56 lines per transcript (range 11 to 170). With more questions in the second interview protocol relating to this area, the amount of transcript material coded in this category rose to an average of 85 lines per transcript (range 30 to 227).

Like the category which considered students' use of computers, learning about computers encompassed a broad spectrum of participant responses. Some of the areas addressed by participants included:

- Lack of time during student teaching experience
- Value of being in classroom environment
- Learning computer skills by exploration vs. in formal settings
- Learning from friends and family
- Learning from co-operating teachers

Time constraints. In a one year program which combines the requirements for an M.A. in Education with the requirements for teacher certification, it is not surprising that participants felt pressured for time. Seven (Barnard, Greenwalt, Hendry, Mallery, Sims, Soles, and Stout) of the eight second round interview participants mentioned time as a factor which kept them from learning as much about technology as they would have liked during the semester between the first and second round interviews. In this quote, Needham reflects on the variety of needs which competed for her attention:

> Needham: I'm nowhere near knowledgeable, yet. And there's so much else... not this year. There's so much else.
>
> Margerum-Leys: Like what?
>
> Needham: All these little things are coming up, that I just either forgot about or didn't even consider. Little things... like bookkeeping, where I'm going to keep my grades, and there's a lot of...the initial stuff you need to get settled. And it's occupying a lot of my time and thought. So, once I get over that, maybe I can find time for other things. (Needham, Second interview)

Value of being in classroom environment. Participants recognized the importance of exposure to educational settings, both for their own growth as teachers and for examples of how computer-based technology might be used. In the quote below, Stout talked about the value he saw in being able to observe an instance of teaching aided by the use of a classroom computer:

> It's almost unlimited, you know? I was tripping out, I was like 'man he's showing, he's showing the actual' map, he showed actually where people went from, to, where, what part of ...Vietnam it was. ...I was like 'that's pretty amazing.' So, I was pretty impressed about [that]. (Stout, Second interview)

At the first interview, participants predicted that seeing examples of practice would be an important part of their teaching placement experience. Responding to a question about how he might acquire new skills and ideas for using technology in his teaching, Sims said: "I think it's probably a lot of

it will be through, meeting people that do 'xyz' with the computer and wouldn't that be fun to do in a classroom or wouldn't that be a good thing to do in the classroom." (Sims, First interview)

By the second interview, five (Barnard, Mallery, Sims, Soles, Stout) of the eight participants commented on the importance of being exposed to computer technology as used in educational settings.

> Computers were...being used in my classrooms and in my school in ways that surprise me.... I think on the whole, my attitudes are probably the same, although I have had those few experiences that have made me kind of think, well, you know, there's more to it than I understand now. (Sims, Second interview)

> I think the major thing is that I've gotten to see the other issues concerned with technology in the classroom. Stuff I didn't think about like technical issues... and it was interesting because again I think it really helps me clear myself up. (Stout, Second interview)

For these participants, classroom experience was a key factor in both learning about computer-based technology in the K-12 classroom and for solidifying their beliefs about that technology's appropriate role.

Learning through exploration compared with learning in formal settings. Lave (1988) raises issues which may shed light on participants' beliefs about formal instruction in the use of computer-based technology and the tension between these beliefs and participants' value of learning through experimentation. Lave's claim is that because transfer tasks analyzed in the lab are so artificial, they do not reveal anything about transfer in the world outside of the research setting. There may be a parallel to technology "training". If training occurs in artificial settings, lessons learned in training may have little bearing on participants' real-world needs.

Five participants expressed beliefs about the role of formal experiences, defined for this study as credit classes or workshops designed to help students learn to use technology. Three study participants were generally negative about formal learning experiences, two were generally positive. On the negative side, Barbara Greenwalt had this to say about her high school experience:

> At school we had a ... computing class, and they tried to get us to learn how to do some programming with BASIC...to do something with it. To have more of an idea how it worked. But I cannot even remember what we did. So I'm assuming that it was worthless. (Greenwalt, First interview)

Where participants did feel positively about formal instruction, they emphasized the importance of guided practice as a large part of the instructional program. In this exchange, Soles discusses her experience with a preservice course in technology use in a previous teacher education program at another institution:

> Margerum-Leys: What did you think about that course?

> Soles: It was very helpful. We did a lot of hands on stuff....Most of us had no experience, no exposure to that kind of stuff, so it was very helpful....[the instructor] tried really hard... to get us to use as many things as possible, in the amount of time that we had. So it was good. (Soles, First interview)

More common than comments about formal instruction were beliefs about learning by doing as a more beneficial way of learning about computer-based technology. Karabotsos' impressions were typical of beliefs expressed by participants:

> Karabotsos: I learned a lot of things along the way. How to cut and paste. You know, at first I was just using it probably in the same way ... a person would use a typewriter. With the exception that I could delete things. But, I've become a little bit more sophisticated over the years, picking up little things when I need them.
>
> Margerum-Leys: Like?
>
> Karabotsos: Well, cutting and pasting is the big one for me. And also being able to export things, and take stuff from word processed text and bring it to put it on e-mail or vice versa. And that type of stuff I've picked up over the years slowly but surely. A lot of it is just fooling around. (Karabotsos, First interview)

This belief about their own learning extended to participants' beliefs about the benefits of having students learn by exploration, including working with students while both the teacher and the student struggled to learn a new skill. Stout had this to say about students and teachers experimenting together to learn about technology:

> Because, when I do it with a student, me and the student are probably on the same level. Which is a great thing.... it's not great for the fact that if there's a problem, it's not easily overcome, but it's gonna be overcome, you know? And...to me that's a kind of an advantage of it...because I get to learn with them, and they get to see that. That... me and them are gonna make mistakes together and learn together with that way. So that's kind of good. (Stout, Second interview)

The literature on teacher preparation in technology supports this view. Willis & Mehlinger (1996), in a comprehensive review of the literature, found that formal, stand-alone courses on technology use were seen in the research he reviewed to be of less value than incorporation of technology learning into subject area methods courses. Stand-alone courses on instructional technology, according to Willis, tend to be more behaviorist in orientation, teaching declarative knowledge and assessing using traditional testing. Technology as folded into methods classes is viewed as more progressive and constructivist. Participants in this study might take that to the next step, valuing the incorporation of learning about technology into their field experiences. This would parallel the findings of Woodruff, Brett, and Chakravorty (1998) whose research participants placed a high value on experimentation during their teacher preparation, extending into their field experience. Notice that this is in contrast to participants' belief that a lack of time kept them from learning more during their student teaching placement.

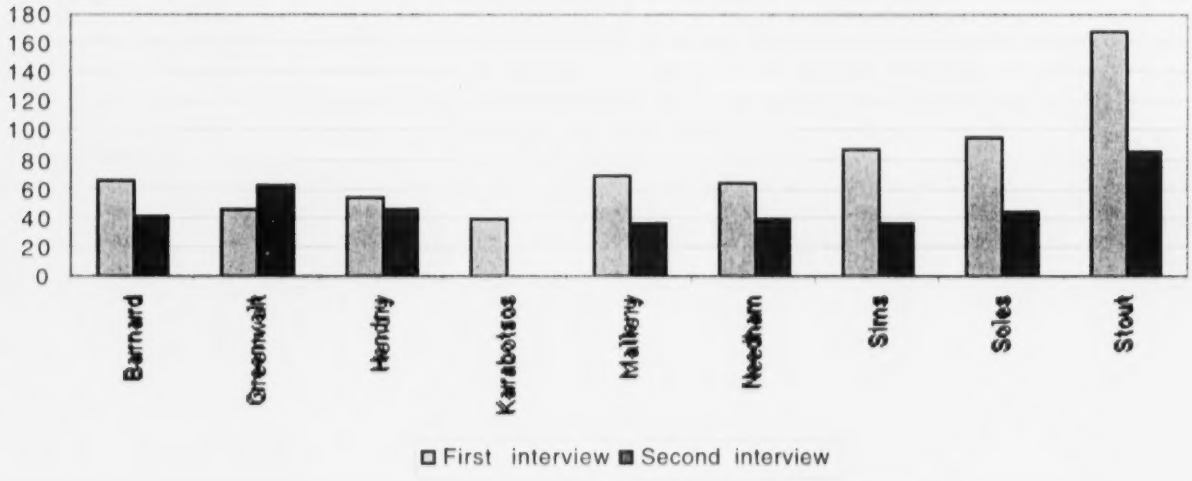
Learning from friends and family. Conventional wisdom as often expressed in the popular media holds that younger people are more technologically savvy than their elders and that your average sixth grader has a lot to teach her parents about computers. For participants in this study, though, the roles were often switched. Sims' father, for instance, was a source of technology learning for him: "My dad is much more into computer technology than I am. So I usually use him for a resource for things that are going on" (Sims, First interview). Soles was even stronger in her feelings about learning from her mother: "My mom could show me, my mom's totally Miss Internet. [Laughs] And my mom is in her fifties." (Soles, First interview) Five of the nine participants (Greenwalt, Hendry, Sims, Soles, and Stout) attributed some learning about computer technology to one of the their parents. This finding is probably related to the socio-economic background of participants' parents. All but one (Greenwalt) of the participants have parents who work in white collar positions. Still, it's interesting that for these grown children of professionals, mom and dad are a valued source for technology learning.

Learning from co-operating teachers. Related to both learning by informal exploration and learning from parents was a belief on the part of some participants (Soles, Needham, and Stout) that their co-operating teachers were helpful in learning about computer technology. Participants felt at ease

learning alongside their co-operating teachers in an exploratory way because the relationship they had developed was a comfortable one. Soles' comment from the second interview illustrates this feeling: "She can do all three now [e-mail, Internet, and grade keeping]. Between the two of us, we worked it out." (Soles, second interview)

Knowledge about Computers

Figure 11: Knowledge about computers, lines per participant per transcript



Responses coded in the knowledge about category referred to the kinds of skills and information participants believed they and their students should know about computer-based technology. Previous category responses, coded as "learning about computers," referred to how participants believed they should come to know these things. "Learning about computers" was process oriented, while "knowing about computers" referred to stable pieces of knowledge.

Figure 11 above shows the distribution of responses in this category. In the first interview series, "knowing about computers" accounted for an average of 77 lines (range 39 to 169) of transcript. Responses in this category dropped in the second interview series to an average of 49 lines (range 36 to 86) of transcript. The percentage of transcripts dedicated to this category also dropped from the first to the second rounds, falling from 9.9% to 6.7%. As with all of the categories, it is important to caution that the two interview protocols were different, making it unwise to make too much of differences, but it is worth noting that participants' responses regarding learning about computers were higher in the second interview than the first, while responses regarding knowing about computers were lower in the second interview. Participants talked more about the process of learning in the second interview, having seen this process in action; they were less concerned with listing things which students should know and more interested in how students might acquire skills and knowledge.

When participants discussed knowledge about computers, their comments focused on what knowledge they believed they needed for their own use, whether their own knowledge was sufficient, beliefs about what knowledge constituted expertise, and beliefs about how knowledge about applications transferred among software and situations.

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Knowledge needed for own use. Especially in the first interview, when they had little experience in their teaching placements, participants tended to view computers as primarily a teacher tool. When asked about potential uses for computer-based technology, eight of the nine participants (Barnard, Greenwalt, Hendry, Karabotsos, Needham, Sims, Soles, and Stout) mentioned keeping student grades and other assessment information for which they envisioned using computers.

Many participants also mentioned the value of knowing how to use computers to make presentations in their classrooms. This is a use for computers which, on the plus side, makes use of a single computer in the classroom; on the minus, the computer is used only by the teacher and is likely to be used in a transmission mode of teaching.

Beliefs about sufficiency of own knowledge. When asked whether they considered themselves an advanced technology-using teacher, study participants generally indicated that they did not believe they were. However, most reported that they used e-mail on a daily basis, were accomplished in the use of word processing programs, and could use the World Wide Web to find information of use to their classroom practice. These would be unusual skills to find in all but the most advanced teachers. In almost every case, participants indicated that their own skills were well above those of their cooperating teachers. Still, when asked directly about whether or not their own computer skills were adequate, participants were ambivalent. Six of the nine participants (Barnard, Greenwalt, Hendry, Needham, Sims, and Stout) expressed both feelings of adequacy and feelings of inadequacy at various points in the interviews. Generally, participants felt that while their knowledge was sufficient for their own needs, they would need to know more before feeling comfortable using computer-based technology as a teacher. Sims' response in the second interview was an example of this belief:

> It goes back to the split between what I know how to do for myself and then what I would know how to use in the classroom. And for me... most of those things I feel comfortable doing and I feel much less comfortable teaching, as far as, I don't really know the ins and outs. (Sims, Second interview)

The beliefs of study participants parallel the results of a survey by the Michigan State Board of Education (1990). Most teacher education students surveyed had used computers for word processing, but only 23% felt prepared them to use computers in their own teaching.

What knowledge constitutes expertise? When considering expertise in general, participants focused on using computer applications as well as interactions with students. When asked what would constitute an "advanced technology-using teacher," software use was the most frequently cited, with eight of the nine participants (Barnard, Greenwalt, Hendry, Mallery, Needham, Sims, Soles, and Stout) indicating that well-developed use of software would show that a person was an advanced technology using teacher. Mallery's response shows the place of software use in her consideration of expertise:

> They've [advanced technology using teachers] got to know how to type. Touch type. They've got to be able to use a computer...by use a computer I don't necessarily mean program....You've got to know what a database is. You've got to know...how to use word processing...they have to know about how a computer works, I think. (Mallery, First interview)

Incorporating computer-based technology in teaching and learning was equally cited as an indication of expertise, with all of the participants mentioning interaction with students as evidence of being an advanced technology using teacher. Greenwalt's response typified this belief:

> The key of like advanced technology [emphasizes] **using teacher** would be, you would actually have to be doing this stuff. You'd have to find ways, to... have all your kids

> doing a project where they... surf the Web for part of their research. And you did it supervised as a class, and maybe you discussed your findings or you could show the kids how you could collaborate over the Web by e-mailing each other Web sites and saying 'what do you think of this?' And using that kind of communication...and making it work in the classroom. So it wouldn't be necessarily that you'd have all these big machines in the classroom and you'd be doing all this technological stuff. It could be just having it integrated into your curriculum so that you didn't really notice it. (Greenwalt, Second interview)

Programming and other computer-centered activities such as computer repair were a distant third to knowing about software and being involved with students using technology. Only two participants (Barnard and Stout) defined expertise in programming or computer-centered terms, and their statements were not in response to thinking about what it might mean to be an advanced technology using teacher.

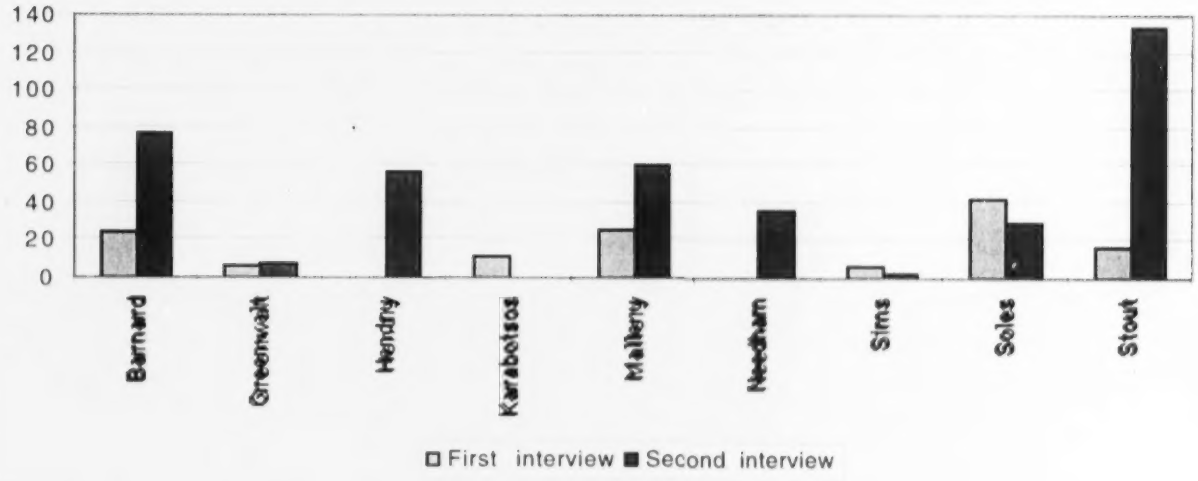
Transfer of knowledge among software and situations. Three participants (Greenwalt, Soles, and Stout) made reference to transferring knowledge between different pieces of software and different situations involving computers. They saw flexibility in using software and the ability to transfer knowledge across situations as being a natural result of their general computer literacy and of the nature of the software they currently use. In this exchange, Beth Soles discusses her use of software which was new to her:

> Margerum-Leys: You mentioned the e-mail and the gradebook. And neither one of those was something that you'd used before?
>
> Soles: Right. Well, I had used e-mail, but not that program.
>
> Margerum-Leys: Not that program.... But you were able to transfer pretty quickly?
>
> Soles: Oh, absolutely. That's not a problem.
>
> Margerum-Leys: And even to teach it?
>
> Soles: No [it's not a problem].... The programs are so self-explanatory now though. I mean, they weren't that easy five, ten years ago. But now, any dummy can use it. (Soles, First interview)

In a 1989 case study, Singley and Anderson (1989) found that knowledge of software does transfer between different software packages. In their study, participants were able to transfer skills learned in one text editing program to another text editing program. This transfer occurred with both structural (how the program controls were laid out) and abstract (what the program capabilities were) knowledge.

Availability of Computers

Figure 12: Availability of computers, lines per participant per transcript



Participants unanimously felt that lack of facilities would be a significant impediment to infusing learning with technology. Despite there being no questions in either interview protocol which directly queried participants about this issue, every participant mentioned availability of technology as an important issue.

Beth Soles' comments are representative of the way participants viewed the issue:

> ...the only thing that I can say that's been negative about computers is there isn't enough of them. [Laughs] In the schools, for you to be able to use them. I'd like to be able to take a whole class down to the computer lab and say 'here we are' and 'everybody can use this, we are right on these today.' (Soles, Second interview)

The views of these participants are echoed in the literature. Byrum and Cashman (1993) report that in a 1992 survey of 426 teacher education students, over 80 percent believed that access to technology would be a severe impediment in their teaching. Availability of computers is cited as a problem for inservice teachers by Buchsbaum (1992), who makes a connection between the availability of technology and the effectiveness of inservice teacher training. Availability is a factor in the entire spectrum of technology use, from envisioning uses for technology to preparing teacher education students and training staff to implementation.

Discussion

When looking at the broad scope of the findings from this study, some results stand out generally; they recur across categories or are particularly pronounced within a category.

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Table 5 summarizes these results, which are discussed in detail below.

Table 5: Summary of findings

	Findings From This Study
Optimism	Participants were generally optimistic and enthusiastic about the role of technology in teaching. While some had reservations about the social implications of increased technology use, most were very positive about increased motivation and improved student learning they believed the use of computer technology fostered.
Exploration	Participants generally found more value for themselves in learning computer skills by exploration than through formal educational experiences.
Access	Access to technology, most participants believed, was still a major stumbling block to the implementation of technology in schools; some participants connected this to social issues such as the "digital divide" between wealthy and poor schools.
Time Barriers	Although they recognized the value of exposure to educational settings as crucial to their learning, participants lacked the time during their student teaching placement to acquire new skills in using educational technology.
Competence	In comparison with the norm for practicing classroom teachers in the same geographic area, participants' computer skills were quite high. Most felt comfortable using technology as a teacher tool, though they were less assured that their skills were sufficient to incorporate computer-based technology into their classroom teaching.
Inter-generational learning	Contrary to the popular media portrayal of the parent/child relationship regarding computers, in which younger people know more about computers by virtue of their age, a surprising number of participants had learned their computer skills from their parents. If this was due to the relatively high socio-economic standing of the participants, there may be implications for issues of equity.

Optimism regarding computer technology. Although they lacked extensive experience using technology in their own teaching, participants were optimistic in their beliefs about the value of using computers as a part of the teaching/learning environment. They believed that the use of technology would lead to increased student motivation, greater place for student voice and authentic exploration, and improved student learning. This optimism toward the changes technology might bring to education can also be found in educational literature (see for instance Negroponte, 1995; Papert, 1993). Negroponte's vision of computers as enabling increased project-based learning aligns especially well with participants' views on the promise of technology, though it tends to conflict with their concerns about access in that the projects envisioned by Negroponte require a high level of access to technology. Papert's (1993) optimism about computers springs from his view that they allow children to learn in a more natural way than traditional schooling allows—he sees the full implementation of computing in the educational process as leading to the demise of formal schooling as we know it. Participants in this study shared Papert's optimism without sharing his more radical views on the educational structure.

Students in the current study did not need to be convinced of the importance of technology to their teaching. They were optimistic about the use of technology and had high expectations that technology would have a positive impact on their students' learning. Capitalizing on their positive beliefs regarding technology may be a challenge. Radical visions of technology as disempowering teachers or visions which do not take into account the reality of access issues may not resonate with the optimism shown by these participants.

Learning through exploration. By using computers for authentic tasks, participants believed that their skills in using computers would grow. While some also found value in formal educational experiences centered around the use of computer technology, a belief in the value of exploration as the major source of learning was more predominant. Again, this aligns with Papert's view of learning, although as with their optimism about technology generally, participants did not seem to believe that the logic conclusion of their value of learning through exploration would be the dismantling of formal schooling.

Echoing recommendations of the literature (Willis & Mehlinger, 1996), formal classes centered on computing would be less well received by these participants than opportunities to learn about computer technology through exploration and authentic tasks. By embedding these opportunities within the teacher education structure, participants' beliefs about their learning could be capitalized on to aid in their growth.

The process of exploration described by participants can be thought of as a construction of meaning. By using computers for authentic tasks and learning through these tasks, participants were able to make connections between their needs and the tools available to them. Richardson (1997) argues that the construction of meaning can be a powerful part of the teacher education process, moving teacher education beyond teaching about constructivism to teaching in a constructivist manner. Perhaps teacher education regarding technology can be shaped to allow teacher education students the opportunity to explore through authentic tasks and the connection to their own teaching can be made explicit as part of the teacher education process.

Access to technology. When participants related their beliefs about technology, their optimism was often accompanied by a caveat that the potential benefits they believed technology could bring were premised on adequate access to technological resources. This caution, in addition to being prevalent enough to warrant a coding category of its own, influenced participants' beliefs in other coding areas. For instance, statements about how students might be motivated through the use of technology were tempered by consideration of whether the appropriate technology would be available to students.

Access to technology is cited as a concern in other research involving teacher education students (Byrum & Cashman, 1993) as well as inservice teachers (Buchsbaum, 1992). Historically, access to forms of technology other than computers has been a factor in keeping those forms of technology from reaching their potential and is seen as a major challenge to attaining the promise offered by the use of computer technology in teaching and learning (Bork, 1991; Cuban, 1986). Through bond issues and increased regular-budget expenditures, schools are purchasing more computer equipment than they are retiring (President's committee of advisors on science and technology, 1997), which is cause for optimism that access to technology will improve.

Tension between grounding in practice and time constraints. Experience in practice as a grounding for reflection and as a basis for growth is a vital part of teacher education (Borko & Putnam, 1996). Others have suggested that experience in educational settings is a major source of teacher education students' beliefs (Richardson, 1996). To engage students in grounded reflection and maximize the integration of learning about technology with teacher education students' existing knowledge and belief structures, the Preservice Technology Project (1989) recommends that teacher education programs incorporate learning about technology into both course work and field placements.

Participants in the current study also saw the value of grounding in practice. When they voiced beliefs about technology—especially in the second interview after they had a semester of exposure to classroom settings—these beliefs were illustrated and supported with examples from their practice. Woven into their belief that exploration was a valuable means of learning was a belief that their field experience offered opportunities for that exploration, if available technology allowed.

However, there was a tension experienced by the participants between the value of practice and the time constraints in their teacher education program. Time is a critical factor in growth; without adequate time, any change is difficult to accomplish (Wideen, 1992). In the current study, participants' reported lack of time was interwoven in their beliefs about how and when their goals for learning about technology might be best accomplished.

The timing of opportunities for learning about technology is important. During their initial field experience, teacher education students lacked the exploration time they felt was essential to acquire technology skills and make those skills a part of their teaching practice. This is in tension with the value they placed on being immersed in the classroom environment. A tighter integration between the requirements placed on them by their field experience and desired skills and knowledge about technology might streamline the teacher education process and/or make learning about technology a higher priority for teacher education students.

Teacher education students' computer skills. In order to use technology in their teaching, teachers must "be comfortable with it and see it as a resource that enables rather than interferes with daily teaching" (Blanchard, 1994, p. 188) Echoing the findings of other research, participants in this study felt comfortable with computers, at least for their own use, and were able to articulate their beliefs about computers as used in K-12 education, in their own teacher preparation, and for their personal use. If "daily teaching" includes activities such as management of classroom data like attendance, participants felt that technology was definitely a resource. On the other hand, if "daily teaching" is limited to interaction with students, participants were concerned that a lack of access to sufficient technological resources was a severe limiting factor. "Enabling" and "interfering with" daily teaching are not necessarily contradictory. Technology may enable teacher tasks while complicating teaching and learning. For most participants, though, enthusiasm about technology and some level of comfort with it was the rule.

Generational factors in technology use. While not a major finding of this study—it did not appear in all participants and did not significantly occur across categories—I was surprised by the nature of some participants' learning relationship with their parents. It is a cliché in popular culture that younger people "get" computers (see for instance, Intel Pentium advertisements which use these exact words). For some of the study participants, though, parents were a valued source of information about computer-based technology. It may be that study participants, who were for the most part the children of white collar workers, were not representative of the general population. If this is the case, it raises issues of equity. Children of higher socio-economic status (SES) may have the opportunity to learn computer skills from their parents, while children from lower SES backgrounds may not have the same opportunity. This would tend to perpetuate and exacerbate the disparity between high and low SES students noted by the participants in this study as well as in the literature.

An alternative worth considering, though, is that increased knowledge about technology is becoming the norm for older people as well as young adults and children. As society in general becomes more computer literate, the generational imbalance in technology skills may equalize, allowing an increasing number of K-12 and college students to use their parents as resources for learning about technology.

Limitations and Future Directions

A study comprised of nine participants in one subject area at one educational institution clearly offers an extremely limited glimpse of the nature of the beliefs of preservice teachers about technology. That these nine teacher education students are likely to be among the top academic performers among preservice teachers nationally and that they are engaged in a fairly unusual teacher preparation program further limits the ability of this study to give a general view of

preservice teacher beliefs. However, their beliefs are thought provoking, and may have implications for preservice teacher education.

The small sample size and limitations presented by this sample left me with theories for which I had insufficient data to speculate meaningfully. For instance, prior experience in the role of teacher as a source of beliefs would be an interesting area of study. It seems likely that experience as a nanny (Soles), a substitute teacher (Karabotsos), a private or non-US school teacher (Hendry, Needham, Sims, and Soles), a college lecturer (Mallery), or a worker in the juvenile detention system (Stout) would have an influence on preservice teachers' beliefs about technology as well as teaching and learning in general. In this paper, I have been able, to some small extent, to show how these participants perceive these influences, but further research might help to generalize how teacher education students' prior experiences impact their beliefs.

Richardson, Anders, Tidwell & Lloyd (1991) cite the need for studies which connect beliefs with practice. A future direction for this line of inquiry would be to follow these preservice teachers into practice to see how their beliefs do or do not translate into actions. It is interesting to explore participants' thinking about technology and its role in education, but until that thinking is realized through classroom action, participants' beliefs are by nature speculative.

Of equal importance to exploring teacher education students' beliefs and actions is the need to examine preservice teacher preparation. For the teacher education students in this study, exploration was preferable to formal learning experiences, and adequate time was essential to their learning; altering the structure of preservice teacher education to meet these needs would open up new possibilities for inquiry into teacher education students' beliefs and the consequences of those beliefs.

Conclusion

Classroom use of computer-based technology is a topic of much discussion in both the academic and the popular media. The role of technology in teaching and learning is debated, as is the type and amount of teacher development required to assure that computer-based technology is put to effective use.

The participants in this study believed that time and access were critical components for success in using computer-based technology. These teacher education students believed that students need to use technology in their learning in order to stay current with society; for themselves, they view their skills as adequate for their own use, but insufficient for classroom use.

Knowledge of the beliefs of these teacher education students may help to make teacher education in technology use more effective by encouraging teacher educators to take into account students' need for exploration, the possibility that incoming teacher education students' skills are increasing, and the importance of timing in providing opportunities for learning about computer-based technology.

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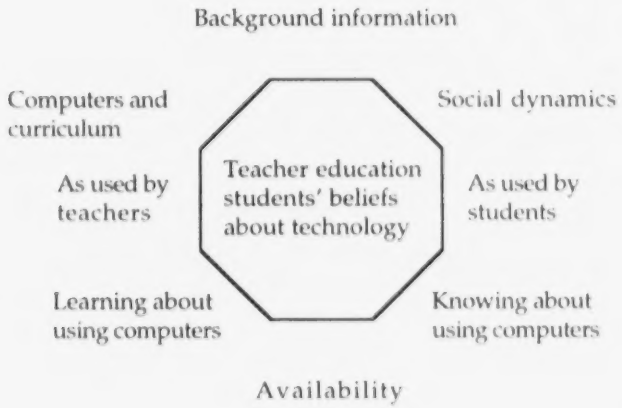
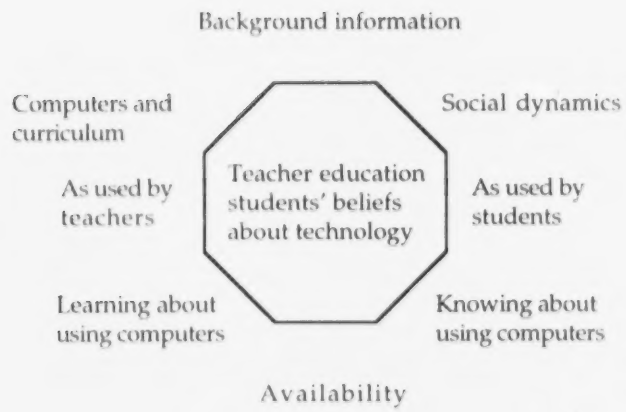
Appendix A: Coding Structure for Study 1

The coding maps below were created by QSR NUD*ST and Inspiration Software's Inspiration. Since the entire map is too large to fit on a single page, I begin with a figure showing the major categories, followed by a separate figure showing each category and its associated codes.

For figures two through nine, the category Figures, the following convention is used: The main topic area for the category is denoted by a darkly shaded rectangle ( ). Subcategories are denoted by an lightly shaded rectangle ( ). Creation of a subcategory occurred when a group of related codes was grouped. For instance, in category 1, "Background Information", separate subcategories were used to group background regarding technology and background outside of technology. Codes themselves are indicated by a shaded oval ( ).

Figure 13: Coding Categories





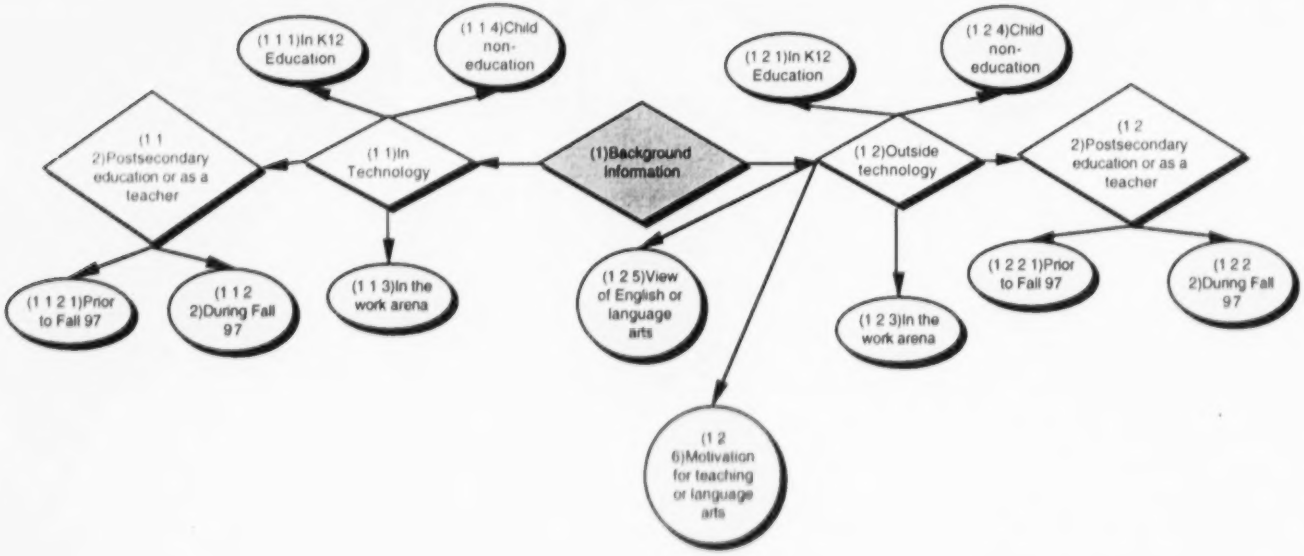

(1 1 1)In K12 Education
(1 1 4)Child non-education
(1 1 2)Postsecondary education or as a teacher
(1 1)In Technology
(1)Background Information
(1 2 1)In K12 Education
(1 2 4)Child non-education
(1 2)Outside technology
(1 2 2)Postsecondary education or as a teacher
(1 1 2 1)Prior to Fall 97
(1 1 2 2)During Fall 97
(1 1 3)In the work arena
(1 2 5)View of English or language arts
(1 2 3)In the work arena
(1 2 2 1)Prior to Fall 97
(1 2 2 2)During Fall 97
(1 2 6)Motivation for teaching or language arts

Figure 14: Background Information, 12 Codes

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Figure 15: Category 2, Social Dynamics of Computers, 14 Codes

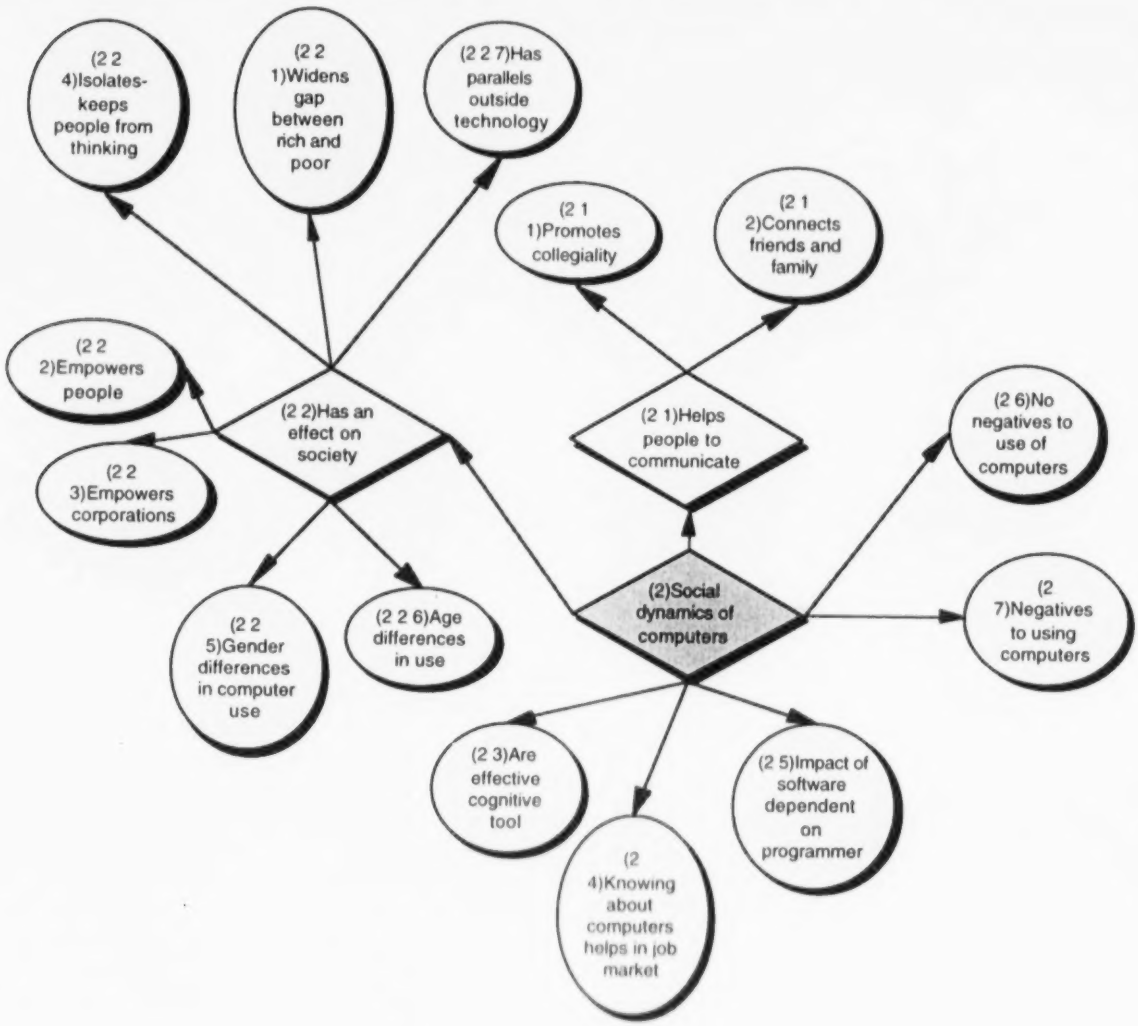
(2 2 4)Isolates-keeps people from thinking
(2 2 1)Widens gap between rich and poor
(2 2 7)Has parallels outside technology
(2 1 1)Promotes collegiality
(2 1 2)Connects friends and family
(2 2 2)Empowers people
(2 2)Has an effect on society
(2 1)Helps people to communicate
(2 6)No negatives to use of computers
(2 2 3)Empowers corporations
(2)Social dynamics of computers
(2 7)Negatives to using computers
(2 2 5)Gender differences in computer use
(2 2 6)Age differences in use
(2 3)Are effective cognitive tool
(2 5)Impact of software dependent on programmer
(2 4)Knowing about computers helps in job market

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Figure 16: Category 3, Computers as Used by Teachers, 7 Codes

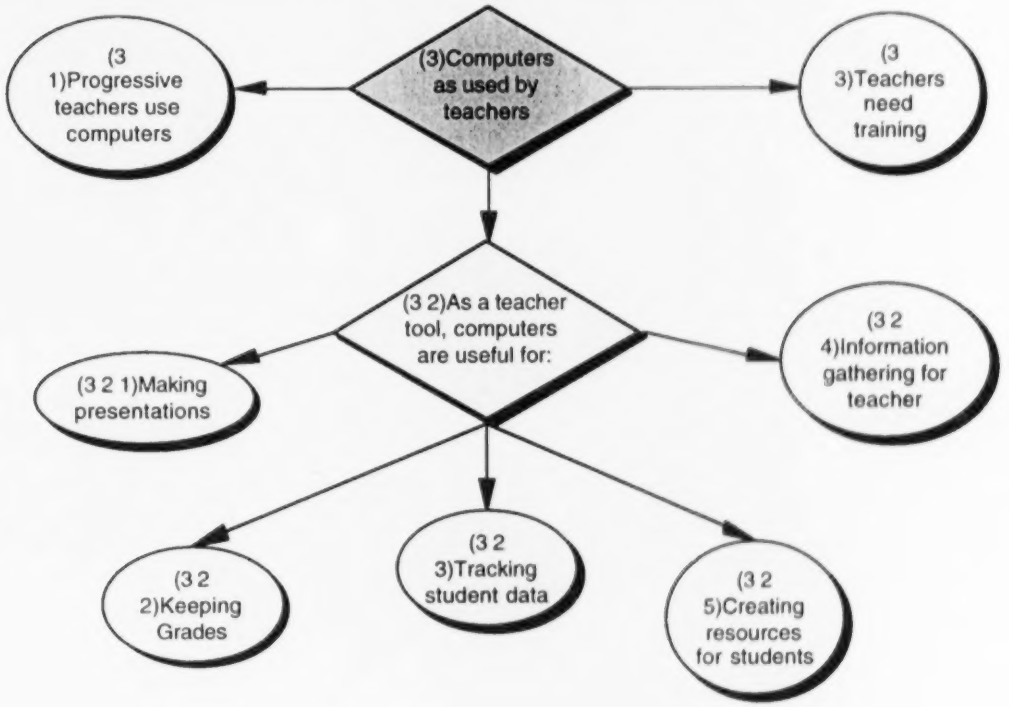
(3)Computers as used by teachers
(3 1)Progressive teachers use computers
(3 3)Teachers need training
(3 2)As a teacher tool, computers are useful for:
(3 2 1)Making presentations
(3 2 4)Information gathering for teacher
(3 2 2)Keeping Grades
(3 2 3)Tracking student data
(3 2 5)Creating resources for students

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Figure 17: Category 4, Computers and Curriculum, 11 Codes

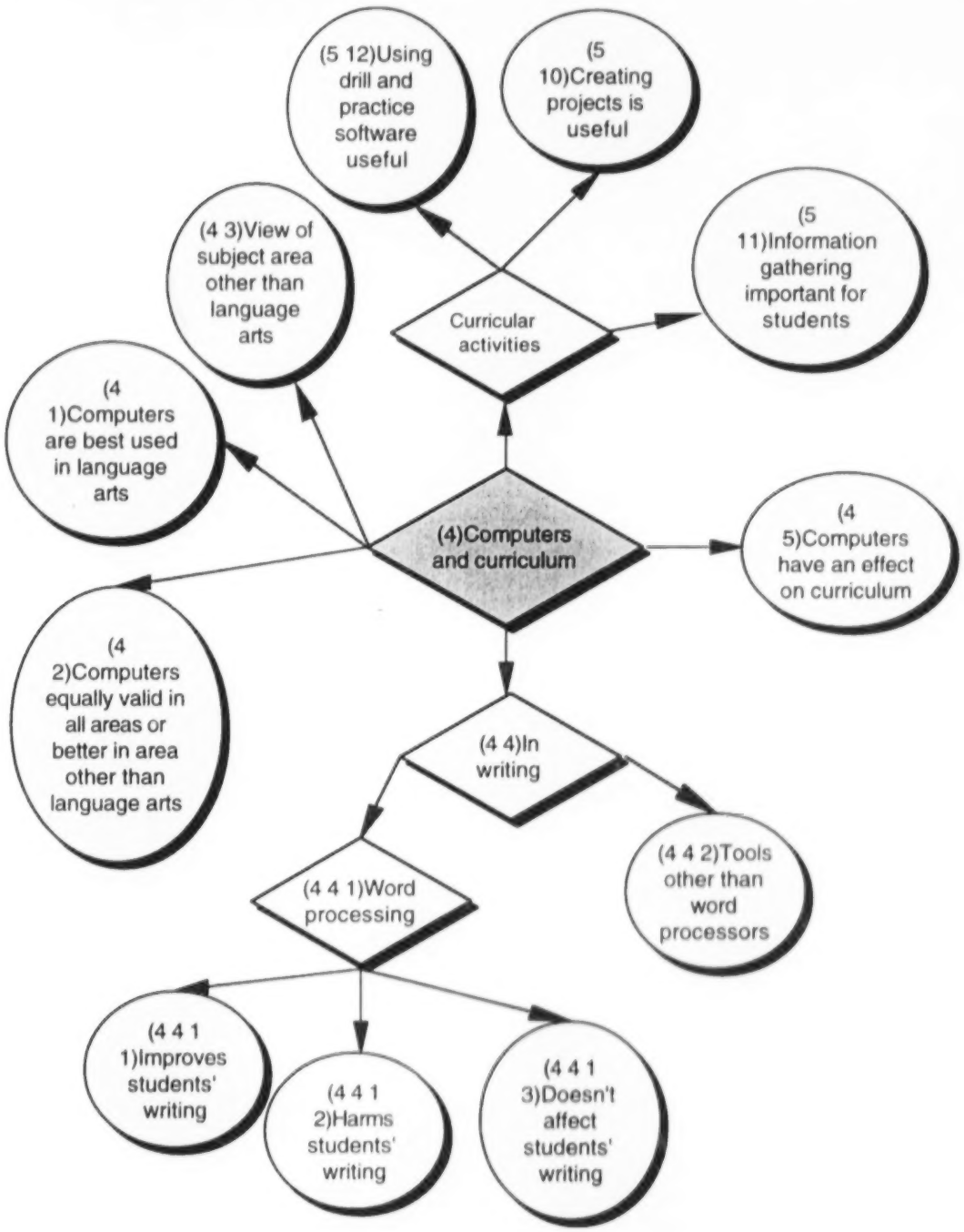
(5 12)Using drill and practice software useful
(5 10)Creating projects is useful
(4 3)View of subject area other than language arts
(5 11)Information gathering important for students
Curricular activities
(4 1)Computers are best used in language arts
(4)Computers and curriculum
(4 5)Computers have an effect on curriculum
(4 2)Computers equally valid in all areas or better in area other than language arts
(4 4)In writing
(4 4 2)Tools other than word processors
(4 4 1)Word processing
(4 4 1 1)Improves students' writing
(4 4 1 2)Harms students' writing
(4 4 1 3)Doesn't affect students' writing

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Figure 18: Category 5, Computers as Used by Students, 13 Codes

(5 7)Differing abilities have an effect
(5 6)Classroom management affects computer use
(5 8)Effective use age dependent
(5 15)Puts students in touch with others
Things which affect computer use
(5)Computers as used by students
(5 14)Has impact on student-teacher relationship
(5 17)All students can use computers
(5 16)Using computers is game-like
(5 1)Need to use computers to stay current in society
Motivation and Cognition
Student-teacher effects
(5 2)Motivation changed through use of computers
(5 13)Gives different perspective than teacher
(5 3)Complete more work when computers are used
(5 4)Computer use may allow less thinking
(5 5)Computers may be distracting

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Figure 19: Category 6, Learning About Computers (Participants), 10 Codes

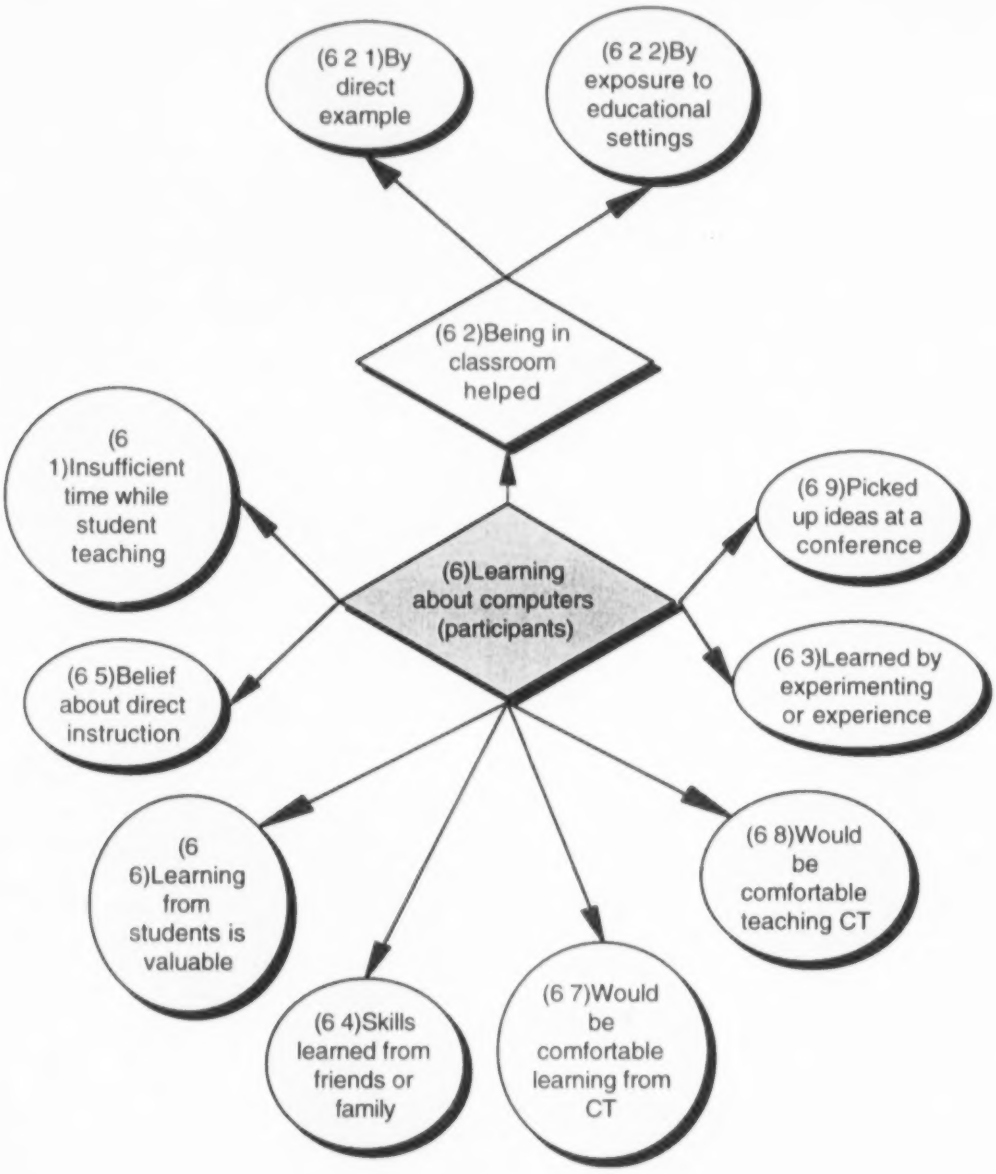
(6 2 1)By direct example
(6 2 2)By exposure to educational settings
(6 2)Being in classroom helped
(6 1)Insufficient time while student teaching
(6)Learning about computers (participants)
(6 9)Picked up ideas at a conference
(6 5)Belief about direct instruction
(6 3)Learned by experimenting or experience
(6 6)Learning from students is valuable
(6 8)Would be comfortable teaching CT
(6 4)Skills learned from friends or family
(6 7)Would be comfortable learning from CT

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Figure 20: Category 7, Knowledge About Computers, 12 Codes

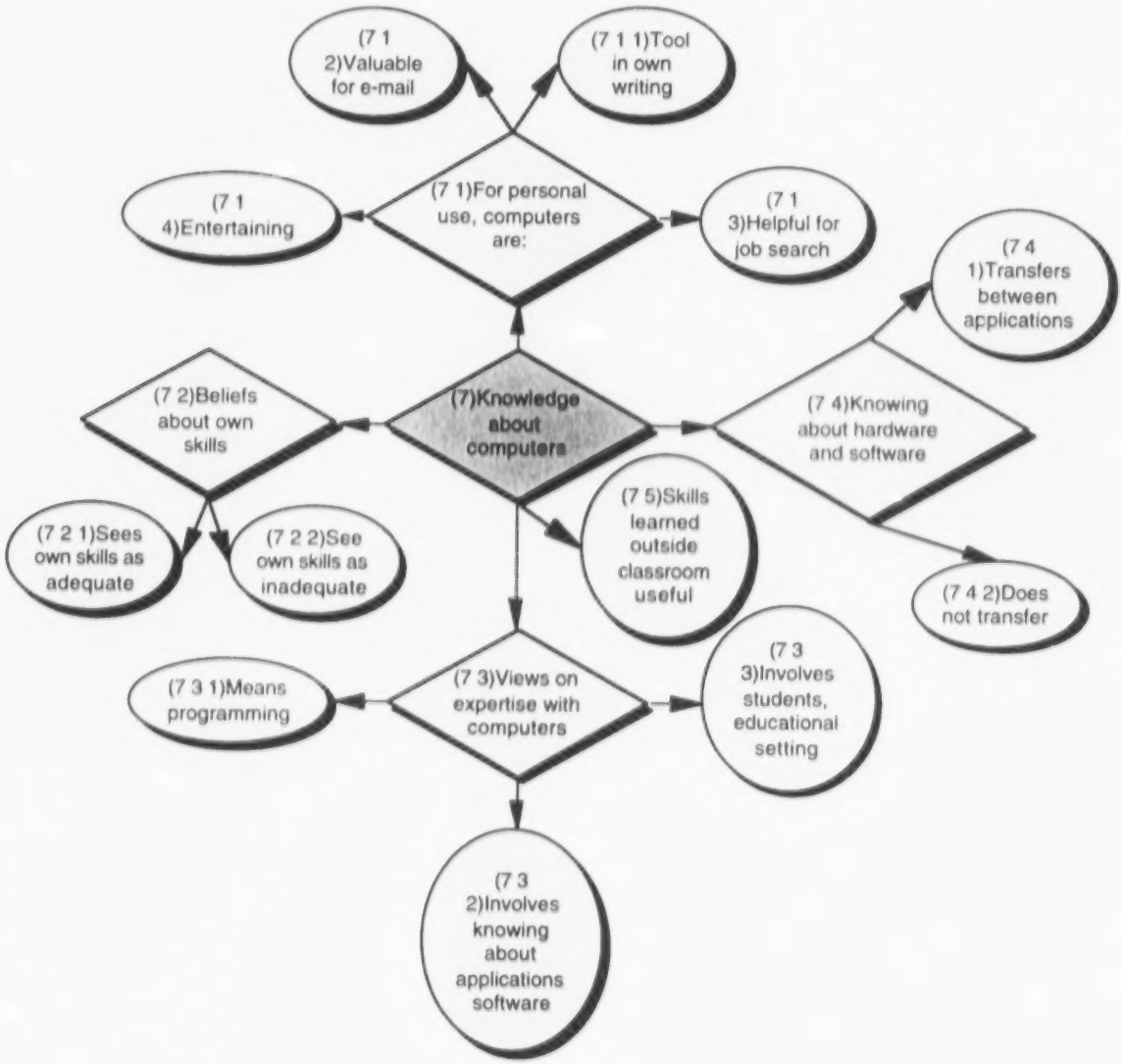
(7 1 2)Valuable for e-mail
(7 1 1)Tool in own writing
(7 1)For personal use, computers are:
(7 1 4)Entertaining
(7 1 3)Helpful for job search
(7 4 1)Transfers between applications
(7 2)Beliefs about own skills
(7)Knowledge about computers
(7 4)Knowing about hardware and software
(7 2 1)Sees own skills as adequate
(7 2 2)See own skills as inadequate
(7 5)Skills learned outside classroom useful
(7 4 2)Does not transfer
(7 3 1)Means programming
(7 3)Views on expertise with computers
(7 3 3)Involves students, educational setting
(7 3 2)Involves knowing about applications software

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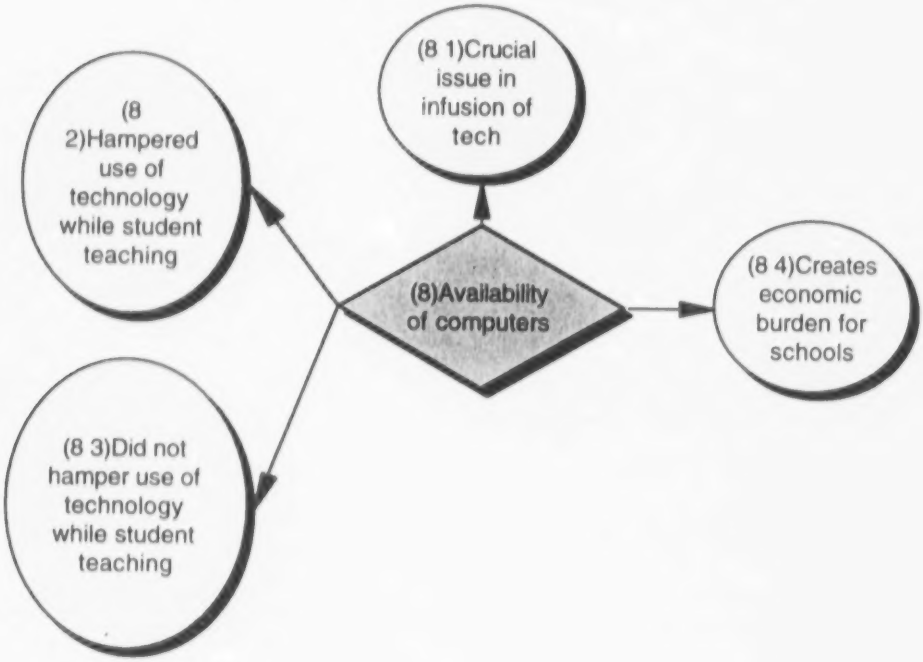
Figure 21: Category 8, Availability of Computers, 4 Codes


(8 1)Crucial issue in infusion of tech
(8 2)Hampered use of technology while student teaching
(8)Availability of computers
(8 4)Creates economic burden for schools
(8 3)Did not hamper use of technology while student teaching

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Appendix B: Coding Response Tables

The tables below show in detail the percentages of participant responses in each of the coding categories, plus the percentage of the transcript taken up by statements by the interviewer and other non-participant text. Due to multiple coding of some responses, the sum of the categories is sometimes greater than one hundred percent. Note that Byron Karabotsos is listed only in table 1, due to his leaving the teacher preparation program before completion of the study.

Table 1: First round response percentages

	Background	Social Dynamics	Used by teachers	Curriculum	Used by students	Learning	Knowledge	Availability	Interviewer
Aaron Sims	48.0%	8.7%	8.1%	3.5%	11.0%	2.0%	16.0%	1.3%	19.0%
Amira Hendry	39.0%	2.5%	3.2%	9.5%	4.6%	1.8%	3.2%	0.0%	17.0%
Barbara Greenwalt	40.0%	5.5%	11.0%	3.1%	18.0%	11.0%	4.3%	0.6%	17.0%
Beth Soles	27.0%	4.1%	0.3%	5.0%	11.0%	23.0%	13.0%	5.6%	27.0%
Byron Karabotsos	25.0%	11.0%	0.5%	13.0%	10.0%	4.3%	6.6%	1.9%	28.0%
Cheryl Mallery	21.0%	1.3%	2.3%	7.3%	6.8%	3.2%	9.1%	3.4%	31.0%
Dawn Needham	20.0%	8.7%	2.4%	5.9%	13.0%	2.6%	13.0%	0.0%	38.0%
Gary Barnard	22.0%	2.5%	4.4%	5.0%	25.0%	3.2%	8.7%	3.2%	18.0%
Quentin Stout	45.0%	9.5%	3.8%	1.2%	6.6%	8.1%	15.0%	1.5%	7.7%
Average:	31.9%	6.0%	4.0%	5.9%	11.8%	6.6%	9.9%	1.9%	22.5%

Table 2: Second round response percentages

	Background	Social Dynamics	Used by teachers	Curriculum	Used by students	Learning	Knowledge	Availability	Interviewer
Aaron Sims	5.3%	6.2%	1.1%	10.0%	24.0%	23.0%	0.0%	0.4%	24.0%
Amira Hendry	24.0%	8.5%	9.5%	5.7%	12.0%	6.1%	11.0%	12.0%	30.0%
Barbara Greenwalt	13.0%	4.9%	6.7%	4.4%	21.0%	4.4%	9.6%	1.2%	25.0%
Beth Soles	7.9%	0.0%	6.3%	13.0%	16.0%	9.4%	7.1%	4.7%	24.0%
Byron Karabotsos	- -	- -	- -	- -	- -	- -	- -	- -	
Cheryl Mallery	12.0%	1.9%	3.6%	2.4%	12.0%	7.9%	7.9%	13.0%	36.0%
Dawn Needham	5.4%	1.5%	6.4%	2.8%	15.0%	7.7%	5.6%	5.0%	39.0%
Gary Barnard	1.4%	6.0%	7.0%	16.0%	20.0%	18.0%	6.0%	11.0%	20.0%
Quentin Stout	12.0%	8.6%	11.0%	2.3%	3.2%	16.0%	6.0%	9.4%	8.0%
Average:	10.1%	4.7%	6.5%	7.1%	15.4%	11.6%	6.7%	7.1%	25.8%

Table 3: Aggregate data: Interview series one and two averaged

	Background	Social Dynamics	Used by teachers	Curriculum	Used by students	Learning	Knowledge	Availability	Interviewer
Aaron Sims	26.7%	7.5%	4.6%	6.8%	17.5%	12.5%	8.0%	0.8%	21.5%
Amira Hendry	31.5%	5.5%	6.4%	7.6%	8.3%	4.0%	7.1%	6.0%	23.5%
Barbara Greenwalt	26.5%	5.2%	8.9%	3.8%	19.5%	7.7%	7.0%	0.9%	21.0%
Beth Soles	17.5%	2.1%	3.3%	9.0%	13.5%	16.2%	10.1%	5.2%	25.5%
Byron Karabotsos	25.0%	11.0%	0.5%	13.0%	10.0%	4.3%	6.6%	1.9%	14.0%
Cheryl Mallery	16.5%	1.6%	3.0%	4.9%	9.4%	5.6%	8.5%	8.2%	33.5%
Dawn Needham	12.7%	5.1%	4.4%	4.4%	14.0%	5.2%	9.3%	2.5%	38.5%
Gary Barnard	11.7%	4.3%	5.7%	10.5%	22.5%	10.6%	7.4%	7.1%	19.0%
Quentin Stout	28.5%	9.1%	7.4%	1.8%	4.9%	12.1%	10.5%	5.5%	7.9%
Average:	21.8%	5.7%	4.9%	6.8%	13.3%	8.7%	8.3%	4.2%	22.7%